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THE PLANT DISEASE BULLETIN

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THE PLANT DISEASE SURVEY

SUPPLEMENT 16

Diseases of Field and Vegetable Crops

in the United States in 1920

June 1, 1921

BUREAU OF PLANT INDUSTRY

UNITED STATES DEPARTMENT OF AGRICULTURE

PLANT DISEASE SURVEY

1920

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DISEASES OF FIELD AND VEGETABLE CROPS IN THE UNITED STATES IN 1920.

Prepared by

R. J. Haskell and J. I. Wood.

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INTRODUCTORY STATEMENT.

The customary sources of information have been drawn upon in the preparation of this summary. Collaborators of the Plant Disease Survey have furnished the major part of the data, as usual, and the names of those who did most of the reporting to the Survey are listed on the opposite page.

Many of these persons were assisted by other collaborators and volunteer reporters whose names cannot be listed here for lack of space, but the Survey wishes to thank them and all others who took part in the reporting service of the year.

The Office of Cotton, Truck, and Forage Crop Disease Investigations has furnished valuable information both directly to the office and indirectly through its "News Notes". The data collected by Inspectors of the Bureau of Markets has also been used freely and F. C. Meier, Pathologist with that Bureau, has contributed interesting material. Notes of the field men of the Bureau of Crop Estimates and reports from the U. S. Weather Bureau, as well as current bulletins and periodicals, have been scanned for matter relating to the plant disease situation of the year.

THE WEATHER OF 1920

The weather conditions over the entire United States for a complete growing season cannot be adequately summarized in the few words that space in the Bulletin will permit. The reader is therefore referred to the various publications of the Weather Bureau for data on this subject. However, for convenience a table (Table 55) and brief statement showing the ways in which the season differed from the normal have been extracted from Climatological Data published by the Weather Bureau. In using these data, however, it should be remembered that monthly averages are necessarily rough and that wide variations occur within a single state.

The season for the country as a whole was cold and late. The month of April was so prevailingly cold that only one state, Florida, had a temperature of normal or above. The rainfall during that month also averaged more than usual in all states except in a few in the Southwest and in Minnesota and North Dakota.

May averaged cooler than normal also in practically all states except a few in the lower Mississippi Valley, a group in the Southwest and in North Dakota and Minnesota. The total rainfall was less than normal in most states although seldom seriously scanty.

June continued cool and in most parts of the country the season remained late. A deficiency of precipitation occurred in a belt extending in a northwest and southeast direction from Washington to Florida, but in the northeastern and western portions of the country an excess of rainfall was reported.

July temperatures were above normal west of the Great Plains except in California, but east of this area the monthly means were below normal as a rule, the deficiency being most marked in the Lake region and upper Ohio Valley. East of the Plains States the rainfall was mainly close to, if not equal to or greater than, the monthly normal.

August averaged cooler than normal in most districts except in the Northeast and in a few Gulf Coast districts. The month's rainfall was usually large, and in the main much above normal, in the Gulf States, Tennessee, Kentucky, and the Atlantic States up to the northern border of New Jersey and Pennsylvania.

September averaged warmer than usual in the Rocky Mountain States and eastward. The month had a large total rainfall in New England and New York, and in the coast districts from North Carolina to central Louisiana. A group of states in the central part of the country also had an excess of rain as did Washington and Oregon. The others experienced a deficiency.

Table 55. Departures from the normal temperature and rainfall by states - April to September, 1920.
(Figures taken from United States

Table 55. Departures from the normal temperature and rainfall by states - April to September, 1920. (Figures taken from United States Department of Agriculture Weather Bureau Climatological Data 1, 1920.)

State	Departure from normal													
	Temperature (°F.)						Precipitation (inches)							
	April	May	June	July	August	September	April	May	June	July	August	September
New Eng.	-1.8	-3.0	-1.2	-1.6	+2.8	+1.7	+3.00	-2.04	+1.35	-0.05	-0.24	+2.00
N. Y.	-2.4	-2.0	-0.6	-2.5	+1.7	+1.7	+0.97	+2.04	+0.06	+1.02	-0.21	+1.31
N. J.	-1.0	-3.0	-0.8	-1.9	+0.3	+1.0	+0.93	-0.83	+2.80	+0.96	+1.31	-0.18
Pa.	-2.8	-3.2	-0.4	-2.7	-0.2	+0.9	+0.96	-1.81	+0.83	+0.34	+0.64	+0.94
Del. & Md.	-1.3	-4.4	-0.5	-2.1	-0.1	+0.4	+1.23	-1.57	+1.34	-0.23	+2.58	-0.16
Va.	-1.1	-5.1	-1.8	-3.1	-1.4	+	+0.60	-1.97	+1.08	+0.25	+2.35	-0.16
W. Va.	-2.0	-3.3	-0.9	-3.0	-0.6	+1.0	+1.42	-1.33	+0.52	+0.53	-0.37	+0.41
Ky.	-5.1	-1.4	-1.8	-1.5	-2.3	+0.8	+2.22	+0.13	-1.06	-0.45	+2.24	+0.54
Tenn.	-1.5	-0.4	-1.6	-1.0	-1.9	+1.3	+3.59	-0.20	+0.41	-0.68	+3.10	+0.86
N. C.	-0.6	-4.3	-0.4	-1.2	-1.0	+1.9	+2.06	-2.41	-0.32	-0.01	+2.30	+0.95
S. C.	-0.9	-3.7	-0.1	-0.9	-1.1	+1.5	+2.21	-1.69	-1.54	-0.30	+1.95	+1.48
Ga.	-0.4	-2.2	-0.1	-0.4	-1.3	+1.5	+3.73	+1.29	-1.10	+0.14	+2.31	+0.05
Fla.	+0.9	-1.6	-1.0	-0.5	-0.6	+0.6	+4.04	+1.09	-0.35	+0.22	-0.50	+1.32
Ala.	-0.8	-1.0	-1.1	-0.6	-2.0	+1.7	+5.00	+0.88	-0.19	-0.16	+2.48	-0.71
Miss.	-0.8	+1.5	-1.4	-0.5	-1.7	+2.6	+4.39	+1.14	+0.10	+0.82	+0.58	-0.19
La.	-0.3	+2.6	-1.5	-0.4	-1.2	+2.5	+0.26	+0.34	+0.42	+2.10	+1.70	-0.02
Texas	-1.1	-1.3	-2.1	0.0	-2.9	+1.8	-2.17	-1.43	+0.39	-0.14	+3.03	-0.65
Okla.	-2.7	-1.2	-0.8	-0.1	-4.7	+0.4	-0.83	-0.05	-1.17	+0.26	+1.96	+0.71
Ark.	-1.4	+1.8	-1.7	-0.3	-2.6	+1.2	+0.89	+2.86	-0.93	+0.43	+0.27	+0.06
Ohio	-4.1	-2.6	-0.1	-3.4	-1.4	+0.8	+2.58	-1.36	+1.01	+0.44	+0.94	-0.16
Ind.	-5.1	-2.1	-1.6	-2.5	-1.8	+1.6	+2.52	-0.47	-0.72	+0.24	-0.19	-0.18
Ill.	-4.7	-1.4	+0.8	-1.4	-1.4	+2.6	+1.16	+0.92	-1.65	-1.14	-0.44	-0.87
Mich.	-4.9	-1.1	+1.4	-3.1	-0.4	+2.4	+0.65	-1.91	+0.90	-0.01	+0.09	-0.57
Wis.	-5.7	-0.6	+1.5	-2.4	-1.0	+3.1	0.00	-	+2.50	-1.50	-0.65	-

State	Departure from normal											
	Temperature (°F.)						Precipitation					
	April	May	June	July	August	September	April	May	June	July	August	September
Minn.	-7.3	+1.2	+1.0	-1.1	+0.4	+4.4	-0.33	-0.35	+1.91	-0.96	-1.58	-0.06
Iowa	-6.3	-1.1	+1.6	-1.8	-2.5	+3.1	+1.73	-1.31	-0.82	+0.26	-0.33	-0.06
Mo.	-4.7	-0.8	-0.5	-0.9	-3.0	+1.4	+0.15	+0.04	-2.16	-0.84	+0.89	+0.92
N. D.	-9.6	+1.3	-0.6	+0.8	+3.4	+2.6	-0.55	-0.81	+0.12	-0.46	-0.72	+0.62
S. D.	-8.8	-0.2	-0.3	-0.1	-1.2	+2.2	+1.36	-1.69	+1.66	-0.57	-0.59	-0.44
Nebr.	-8.4	-1.1	-0.2	-0.3	-3.0	+1.4	+2.55	-0.06	-0.87	-0.67	+0.97	-0.93
Kans.	-4.8	0.0	0.0	-0.4	-4.3	+0.6	+0.33	-0.86	-1.15	-0.26	+1.35	+0.22
Mont.	-6.2	-1.2	-1.9	+3.1	+1.7	+0.9	+0.94	-0.37	-0.58	-0.26	+0.07	-0.55
Wyo.	-8.5	-0.3	-0.9	+0.7	-0.9	-0.4	+1.26	-0.29	-0.43	-0.47	+0.23	-0.33
Colo.	-7.4	+0.9	-0.6	0.0	-2.6	-0.9	+1.13	-0.11	+0.19	-0.58	+0.38	-0.27
N. Mex.	-4.3	+0.5	-1.7	-0.2	-2.1	-0.4	-0.66	+0.47	+0.81	-0.83	+0.32	-0.42
Ariz.	-3.8	+1.4	+0.9	+1.4	-1.2	-1.4	-0.22	+0.02	+0.30	-1.29	-0.17	-0.19
Utah	-5.6	-1.1	-0.5	+1.5	-0.4	-0.4	+0.83	+0.03	-0.21	-0.36	+0.40	-0.26
Nev.	-3.3	+1.4	-1.0	+0.3	-0.2	-0.1	+0.26	-0.44	-0.03	-0.24	+0.51	-0.18
Ida.	-4.6	-1.7	-0.7	+2.4	+0.5	0.0	+0.52	-0.73	-0.26	-0.39	+0.34	+0.52
Wash.	-3.8	-2.9	-1.4	+2.1	+1.2	0.0	+1.01	-0.95	-0.02	+0.08	+0.67	+1.69
Ore.	-3.4	-1.9	-0.6	+0.5	+1.6	-0.3	+1.29	-1.34	+0.21	-0.01	+0.64	+1.80
Calif.	-2.2	-0.4	-1.7	-2.3	+0.6	-2.1	+0.77	-1.02	+0.11	+0.02	+0.17	-0.20

DISEASES OF POTATO

Late blight caused by Phytophthora infestans (Mont.) De Bary.

The year 1920 may be considered as the worst blight year for the late potato states, and in fact for the country as a whole, that has been experienced since 1915 when an epiphytotic swept over the Great Lakes Region and northern Iowa as well as over the northeastern area where the disease is commonly prevalent. The 1920 outbreak was less serious than that of 1915 in that it did not involve Minnesota or Iowa and the losses in Wisconsin and Michigan were slight in comparison.

When compared with the reports for 1919, those for 1920 showed the disease as more severe in Northern New England, less in southern New England; more in New York, Pennsylvania, Ohio, and Michigan; less in Wisconsin and Minnesota; more in Oregon; and less in the early crop of Florida. One of the especially noteworthy differences from 1919 was the outbreak in Ohio, where the disease has not been destructive since 1915 but where, nevertheless, a small amount has occurred annually, and also the extension of the range into Michigan, which has been practically free from late blight rot for the past five years. The state as a whole did not experience heavy loss (not over 1%) but the occurrences were numerous and widely scattered. Michigan is now provided with an abundance of infected tubers, many of which will be used for seed in 1921 and if blight weather prevails in that state this year much damage may be expected. In Maine, New Hampshire, and Vermont the disease was worse than it has been for years. According to County Agent Scribner of Aroostook County, Maine the vines in the northern portion of the county were mostly killed by August 25, thus cutting off practically one month's growth of late varieties. The situation seemed to be worse than in 1918 when 15% loss was reported in Maine. Growers were not so much concerned this year, however, owing to the extremely low prices that they were receiving for the crop. F. C. Meier visited Aroostook, October 19-21 and reported in the Bureau of Markets, Fruit and Vegetable Division Letter, November 18, 1920: 12 as follows:

> "The northern part of the State was most severely affected. This territory includes Washburn, Ft. Fairfield, Limestone, Presque Isle, Easton, Caribou, and Van Buren, all of which are heavy shipping points. In the region south of Houlton, blight is reported as being less severe.
>
> "During the course of this trip many barrels of potatoes were examined, and in every instance some late blight dry rot was found. The Cobblers, since they mature early, were of course least affected. Much dry rot was found at all points on the Mountain varieties, on Spaulding Rose, and on Aroostook Prize. Van Buren storage houses seemed to contain potatoes showing the most injury. This is of interest on account of the fact that the Aroostook Prize is grown extensively in that section. This potato, when sent to New Jersey, becomes the 'Giant'. Several seedsmen are having difficulty in procuring stock sufficiently free from blight for their purpose, and there is little doubt that inspections of seed stock will be requested on account of late blight."

B. F. Lutman in Vermont reported on October 15:

> "Tuber rot is bad especially on heavy clays and will cause a loss through the state of 25-50% of the entire crop. One of the worst blight years we have ever had here."

In Massachusetts, Connecticut, and Rhode Island the disease was worse than in average years but less disastrous than last year when losses of 20, 30, and 25% respectively were reported.

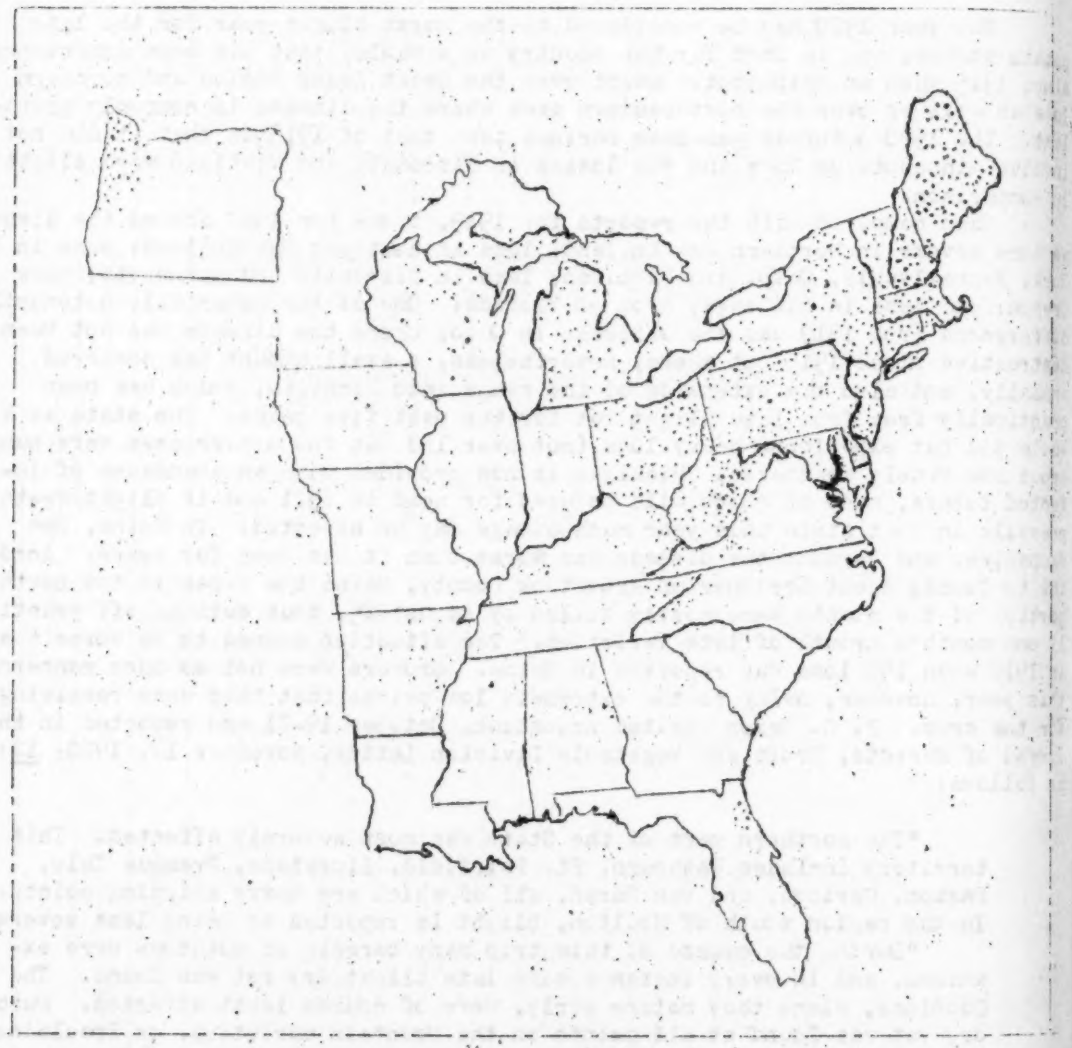


Fig. 38. Geographic distribution of late blight of potato - 1920.

In New York the disease took a heavy toll both by premature killing of the vines, as early as August 1 in many cases, and by rotting of the tubers in field and storage. In connection with the seed potato certification work, percentages of late blight rot were determined on the harvested potatoes in the bin and the average percentage of rot on 436 farms was 4.1%. This figure is lower than on the average farm because many of these farmers sprayed and consequently had less rot. In addition to this loss in the bin there must have been much more in the field from rot of the tubers and blight of the vines.

The following table shows the results of this inspection by counties.

Table 56. Percentages of late blight rot in harvested potatoes as shown by bin inspection, New York, 1920.

County	Number lots inspected	Average percentage late blight rot	County	Number lots inspected	Average percentage late blight rot
Allegany	26	2.96	Monroe	18	0.23
Cayuga	13	0.62	Orleans	23	0.62
Chenango	9	4.00	Oneida	15	0.54
Clinton	34	15.10	Onondaga	36	0.37
Cortland	58	9.04	Ontario	19	2.44
Erie	12	0.51	Oswego	25	4.16
Essex	5	5.10	Rensselaer	2	trace
Franklin	27	4.25	Seneca	14	2.02
Genesee	11	0.02	Steuben	13	1.20
Jefferson	2	0.00	Washington	47	10.47
Livingston	9	0.00	Wyoming	18	2.87
			Total and average	436	4.10

In the potato disease survey conducted by the Pennsylvania Department of Agriculture last year, 521 fields yielding 478,449 bushels were examined for late blight rot. In Cambria County, where 21.3% rot was found, the counts were made in the fields but in the other two counties, Lehigh and Potter, where 6.8% and 8.9% were found, the determinations were made in storage after harvest. It will be seen, therefore, that the percentage of rot in the field was probably more than that in storage, and the Pennsylvania inspectors have estimated the total loss from rot in all three counties as over 20%.

Table 57. Amounts of late blight rot in three Pennsylvania counties, according to survey by Pennsylvania State Department of Agriculture, 1920.

County	Number fields surveyed	Total yield	Percentage of late blight rot
Cambria	175	90,156	*21.3
Lehigh	207	330,868	6.8
Potter	139	57,425	8.9
Total	521	478,449	Av. 12.3

*Counts made in field. In the other two counties counts were in storage.

The loss from blight and rot for the entire state of Pennsylvania was placed by the pathologists there at 25%, which was thought to be a conservative estimate.

In New Jersey there was a large amount of rot on American Giants in the central part of the state, especially the east central part.

In Florida the disease was apparently of less importance on the early crop than is often the case.

In Wisconsin the disease became established in the northeastern part of the state in July but the dry weather of August and September held it in check so that the ultimate loss was small.

In November 1920 the Bureau of Crop Estimates sent out for the Plant Disease Survey a questionnaire addressed to volunteer crop reporters in states where late blight was known to have occurred. The following questions were asked:

1. Were potato vines in your locality attacked by late blight?

2. If so, please answer the following:

   a. When was the trouble first noticeable on the vines?
   b. Were the vines eventually killed by it?
   c. What percent reduction from a normal yield would you estimate took place because of blight of the vines?
   d. What percent of farmers sprayed with Bordeaux?

3. Was tuber rot prevalent in your locality?

4. If it was, please answer questions below:

   a. What percent of reduction in yield from tuber rot would you estimate?
   b. What was the worst case of rot that came to your attention?
   c. Remarks.

5. How have stored potatoes been keeping thus far this fall?

Replies were received from reporters, distributed by states as shown in Table 58.

A summary of the replies to questions 2-c, 4-a, and 4-b, asking for the estimated reduction in yield from vine blight and tuber rot is given in Table 58.

It is surprising to observe the high percentages of loss from both blight and rot as reported by these correspondents. A loss of more than half the crop, which seems very high, is revealed in some states. It is possible that mistaken identity of the disease is a source of error, but it would seem that there should be little chance of confusing the late blight rot with other rots as the others are unimportant in these states, especially at this time of year. The vine blight might be confused with tip burn or early blight but neither of these diseases were destructive in these states last year. On the other hand both the distribution of the losses among the states and the relative amounts of the two forms of the disease agree with other data on hand in the Survey Office. The figures are, therefore, given in Table 58 without comment and each reader can make his own interpretation of them.

A set of estimates based chiefly on those of collaborators is given in Table 59. For further details, including losses in bushels, see Supplement 18 of this Bulletin.

An idea of the amount of late blight rot found in shipments of potatoes may be gained from Table 60. It will be noted that there was more rot in the 1920 than in the 1919 crop shipped during the year.

Table 58. Reduction in yield of potatoes from late blight as reported by voluntary crop reporters of the Bureau of Crop Estimates, 1920.

State	Total number reports received	Percentages reduction in yield from late blight: Vine blight	Tuber rot	Total	Maximum percentage rot in any one field
Maine	196	22.6	24.5	47.1	100
Vermont	133	19.0	28.1	47.1	100
New Hampshire	110	20.8	28.4	49.2	100
Massachusetts	112	16.6	14.6	31.2	100
Connecticut	64	17.4	12.6	30.0	90
Rhode Island	29	17.2	9.8	27.0	90
New York	707	19.2	22.9	42.1	100
New Jersey	87	13.7	9.3	23.0	100
Pennsylvania	597	24.4	16.8	41.2	100
Delaware	24	9.3	7.1	16.4	80
Maryland	132	10.9	5.3	16.2	66
Virginia	91	5.7	4.0	9.7	40
West Virginia	312	14.7	6.1	20.8	75
Kentucky	104	3.5	1.0	4.5	10
Tennessee	102	3.9	5.7	9.6	40
North Carolina	100	6.3	5.1	11.4	50
Ohio	645	16.5	6.6	23.1	100
Michigan	659	10.4	1.8	12.2	100
Wisconsin	531	9.4	1.9	11.3	75
Oregon	104	6.2	5.4	11.6	100
All states reporting	4839	15.2	10.8	26.0	

Table 59. Estimated percentage reduction in yield from late blight and rot, 1920.

Percentage reduction in yield	State
30	Vermont.
25	Pennsylvania.
20	Maine, New Hampshire.
15	Massachusetts, Rhode Island, New York.
10	Connecticut, Maryland, West Virginia, Ohio.
5	New Jersey.
3	Delaware.
1	Virginia, North Carolina, Florida, Michigan, Wisconsin.
trace	Minnesota, Kentucky, Tennessee, Washington, California.

Table 60. Losses from late blight tuber rot caused by Phytophthora infestans, as shown by inspection of cars at destination by inspectors of the Bureau of Markets, calendar year 1920.

January 2 - June 19, 1920			August 5, 1920 - January 15, 1921		
Origin of shipment	No. cars with decay	Average percentage decay	Origin of shipment	No. cars with decay	Average percentage decay
Colorado	1	2	Colorado	1	3
Florida	2	12	Maine	132	6
Maine	106	5	Maryland	2	2
Maryland	5	8	Michigan	45	6
Massachusetts	4	4	Minnesota	3	11
Michigan	1	8	New Jersey	22	5
Minnesota	5	7	New York	81	6
New York	53	3	Ohio	3	8
North Carolina	1	1	Oregon	3	20
Virginia	2	3	Pennsylvania	13	5
Wisconsin	11	4	Wisconsin	2	4
Canada	65	6	Canada	63	8
Unknown origin	15	4	Unknown origin	10	6
Total & average:	271	4.9	Total & average	380	6.4

Total number of cars inspected (approximate)..... 5,140
Total number of cars shipped 166,233

Dates of first observation of late blight, 1920:

March 22 ..... Sanford, Fla.
June 22 ..... Raymond City, West Va.
July ..... Connecticut.
July (early) . New Jersey.
July 11 ..... Suffolk Co., L. I.,N.Y.
July 21 ..... Frostburg, Md.
July 25 ..... Oneida Co., Wis.
July 29 ..... Somerset Co., Pa.
August 2 .... Monroe Co., N. Y.
August 4 .... Rochester, Vt.
August 9 .... Hampshire Co., Mass.
August 13 ... Blacksburg, Va.
August 23 ... Wooster, O.
August 28* .. Corinna, Me.
August 30 ... Center Harbor, N. H.

*Was noted earlier in northern Maine (early in August)

Some of the more significant reports of collaborators and others concerning weather conditions are given below:

New York - Long Island (F. C. Meier): "Although blight was present in many fields on Long Island, there were but few heavy rains following the period when the disease was at its worst; consequently tuber infection by means of spores washed into the soil seems to be rather rare."

Michigan (Waid): "Occurred in scattered places quite well distributed over state. However, weather conditions were such following the

outbreak that comparatively little damage was done considering the number of places which were hit."

Wisconsin (Vaughan): "General drought over most of state held blight in check."

Minnesota (Stakman): "It was so dry during July that the conditions were extremely unfavorable for the development of the disease."

Oregon (Barss): "Early and continued fall rains induced severe late attack in some sections."

Collaborators in New York, Pennsylvania, and West Virginia all said that where spraying with Bordeaux was carefully practiced good results were obtained.

Early blight caused by Macrosporium solani E. & M.

Early blight occurred during the course of the season in practically all of the country. However, it was mentioned as not having been seen in Washington or Nevada. Most of the reports indicate that the disease was generally distributed but in some of the more northern states, like Minnesota and Indiana, it was mentioned as being much more abundant in the southern sections, and in Oregon and Michigan it seemed to be more or less localized, depending on climate, soil or varietal differences.

Although this was probably one of the four or five most universal potato diseases in the United States, in importance it ranked among the minor diseases of the crop. Most of the states experienced losses of less than one per cent. Preliminary estimates indicate that the following losses of more than 1% occurred. For corrected percentage estimates see Plant Disease Survey Bulletin, Supplement 18, 1921.

Table 61. Losses of 1% or more from early blight of potato, 1920.

State	Percent loss	State	Percent loss	State	Percent loss
Pennsylvania	2	South Carolina	1	Ohio	2
New Jersey	2.5	Georgia	1	Indiana	1
Delaware	3	Florida	5	Illinois	1.5
Maryland	1	Alabama	3	Iowa	1
Kentucky	2	Mississippi	3	New Mexico	3
Tennessee	4	Texas	1		

Many states indicate that the disease was much below the normal but some states report it as prevalent in about the usual amounts. However, no records have been received to show that early blight was more important than ordinarily in any one state.

Dates of earliest recorded appearance of early blight, 1920:

May 15 ..... Crystal Springs, Miss.
June 3 ..... Ohio
June 24 ..... Marion Co., Ind.
June 24 ..... Corinna, Me.
July ..... Bedford Co., Pa.
July 13 ..... Bath, N. H.
July 28 ..... Oneida Co., N. Y.
August 1 ..... Madison, Wis.

The disease was usually reported more commonly on early maturing varieties and the Triumph was mentioned as being badly injured in Georgia. It is not suggested that any great differences in susceptibility of varieties exist, however, provided plants of similar age are subjected to similar conditions of environment.

Spraying for this disease with Bordeaux does not seem to be practiced to any particular extent although there are probably many localities where it would pay in certain years.

Fusarium blight caused by Fusarium oxysporum Schlect.

As usual Fusarium blight, or Fusarium wilt as it is often called, was widespread but owing to the lateness of the season and sub-normal temperatures during the summer, the disease was not so destructive as normally. It was most serious in the western potato sections and in states along the southern border of the late potato belt. In Pennsylvania it was mentioned as most abundant in the southeastern part of the state, while in Indiana and Idaho it was reported as especially bad in the northern and southern sections respectively.

In a number of western states this disease often occurs in the same fields and on the same plants with blackleg thus complicating the symptoms and making loss estimates difficult. Mr. Shapovalov found this condition to exist in parts of the Red River Valley of Minnesota and North Dakota and in southern Idaho this past season.

Regarding the seriousness of this disease in the West the Office of Cotton, Truck, and Forage Crop Disease Investigations of the Department of Agriculture has issued the following statement under date of December 11, 1920.

> "The disease affecting the potato plants in the field, variously known as Fusarium blight, wilt, etc., is considered to be by all means the most serious risk to the western potato industry, although scarcely yet recognized as such by the growers. It is the common, perhaps almost universal, experience that yields fall off rather rapidly as potato culture is continued in any western district. This is frequently attributed to exhaustion of fertility and to other diseases, when as a matter of fact, in our opinion, the Fusarium blight is really the responsible cause. This situation is particularly marked in the San Joaquin Delta of California, although severe cases of the disease have been noted in Idaho, Utah, Colorado, and Washington, and it occurs to a greater or less extent throughout the Eastern States also, particularly in the warmer districts. In some localities in southern Idaho and on the western slope in Colorado the percentage of distinctly diseased plants ran as high as 90%. The average per cent of infected hills in the fields surveyed in 1920 is estimated at 20%. The premature death of the plants is hastened by high temperatures such as prevailed in August, 1920, when many Idaho and Colorado fields were completely killed in a few days.

The loss estimate of .5% from Fusarium blight in New York was based largely on the results of inspections that were made in connection with the seed certification work of that state. A total of 440 fields comprising 1392 acres in 22 counties were examined. The percentages of affected plants by counties are given in Table 62.

Table 62. Percentages of Fusarium blight in New York counties where potato inspection work was conducted in 1920.

County	Percentage blight	County	Percentage blight	County	Percentage blight
Alleghany	0.35	Genesee	0.18	Oswego	4.87
Cayuga	4.05	Jefferson	Trace	Rensselaer	8.85
Chenango	Trace	Livingston	1.28	Seneca	0.24
Clinton	0.05	Monroe	1.46	Steuben	2.41
Cortland	Trace	Oneida	0.01	Washington	3.58
Erie	0.69	Onondaga	2.06	Wyoming	0.42
Essex	0.05	Ontario	1.14		
Franklin	0.25	Orleans	2.43		

Average per cent affected plants in state 1.28%
Estimated loss 0.5%

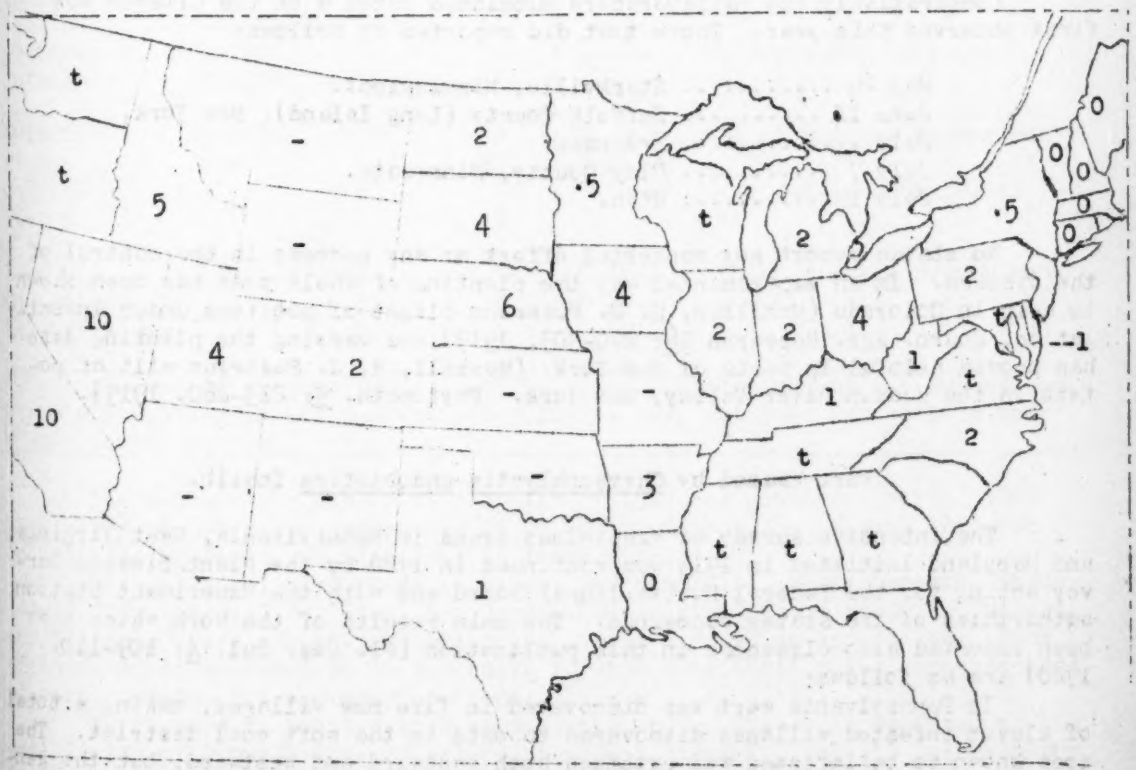


Fig. 39. Preliminary estimate of percentage of loss from Fusarium blight, 1920. For corrected estimate and loss in bushels see Plant Disease Bulletin, Supplement 18, 1921.

In Indiana and Illinois, as in the majority of western states, Fusarium blight was the most important parasitic disease of potato. In the potato sections of the southern states this does not seem to be a disease of any special importance, perhaps because the early crop matures before the advent of sufficiently high temperatures, while the late crop is planted late and reaches a susceptible stage late in the fall when the weather is again comparatively cool. There is no doubt that the range and severity of this disease is greatly influenced by temperature conditions.

The following statement of conditions in North Dakota is given by H. L. Bolley:

> "The disease seems to have been greatly developed this year in the dry land regions wherever seed was originally slightly infected. Drought seems to check the growth of the tuber and thus allows invasion. Perhaps this is not the full explanation but the semi-dry land regions have, as a fact, produced more stem-end rot and wilt than the wetter, heavier lands of the valley."

Inoculation from seed tubers showing vascular discoloration due to Fusarium has not been considered during recent years as a very important mode of infection, especially when the crop is grown in a region where soil infestation exists. However, more observations and experiments are needed on this subject.

Comparatively few collaborators submitted dates when the disease was first observed this year. Those that did reported as follows:

May 25	Starkville, Mississippi.
June 14	Suffolk County (Long Island), New York.
July	Arkansas.
July 7	Clay County, Minnesota.
July 15	Utah.

No states report any concerted effort or any success in the control of the disease. In an experimental way the planting of whole seed has been shown to help in Colorado (McMillan, H. G. Fusarium blight of potatoes under investigation, Journ. Agr. Research 16: 270-303, 1919) and varying the planting date has proved helpful in parts of New York. (Haskell, R. J. Fusarium wilt of potato in the Hudson River Valley, New York. Phytopath. 9: 223-260. 1919).

Wart caused by *Chrysophlyctis endobiotica* Schilb.

The intensive survey of suspicious areas in Pennsylvania, West Virginia, and Maryland initiated in 1919 was continued in 1920 by the Plant Disease Survey acting for the Federal Horticultural Board and with the Experiment Station authorities of the states concerned. The main results of the work which have been reported also elsewhere in this publication (Pl. Dis. Bul. 4: 109-110. 1920) are as follows:

In Pennsylvania wart was discovered in five new villages, making a total of eleven infested villages discovered to date in the soft coal district. The area known to be infested was extended both eastward and westward, but the general situation is not changed. In West Virginia the survey of the northern coal fields was completed without finding wart in any new localities. In Maryland wart was found in three villages near Frostburg, and there is every indication that the disease is more or less abundant in that region. The extensive and growing seed-potato industry in the Frostburg section renders the discovery

of wart there of exceptional importance. Further field work is needed in these three states, as undoubtedly other infested villages remain undiscovered. The present known distribution of wart outside the Hazleton district is as follows:

Table 63. Present known distribution of potato wart outside the Hazleton district.

Town	County	State	No. of infested gardens known	Date of discovery	Discovered by
Nanty Glo	Cambria	Pa.	*2	8-27-19	Plant Disease Survey men
Lilly	"	"	*1	9-13-19	" " " "
Llanfair	"	"	*12	9-23-19	" " " "
Vintondale	"	"	*2	9-27-19	" " " "
Osceola Mills	Clearfield	"	*5	10-8-19	" " " "
Clarence (Snow Shoe	Center	"	*2	10-14-19	" " " "
Woodvale	Huntingdon	"	2	7-29-20	" " " "
Robertsdale	"	"	7	8-3-20	" " " "
Janesville (Smithmill)	Clearfield	"	2	9-1-20	" " " "
Beaverdale	Cambria	"	1	8-18-20	Pennsylvania State men
Yatesboro	Armstrong	"	3	-20	" " "
Whitmer	Randolph	W.Va.	2	9-19-19	Plant Disease Survey men
Thomas	Tucker	"	21	9-12-19	" " " "
Coketon	"	"	2	-20	West Virginia State men
Pierce	"	"	2	-20	" " " "
Lord	Allegany	Md.	1	9-15-20	Plant Disease Survey men
Mt. Savage	"	"	1	9-19-20	" " " "
Eckhart Mines	"	"	1	9-21-20	" " " "

*Number of gardens found in 1919. The 1920 findings by the Pennsylvania State authorities in the quarantined villages have not been reported to the Plant Disease Survey.

The nation-wide publicity campaign of 1919 was continued during 1920 in a minor way by correspondence. It is believed that the general interest in watching for wart was sustained in large measure.

Carefully selected areas in Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Ohio, Michigan, Wisconsin, Indiana, and Illinois, were visited and extensive garden inspection undertaken. Many of these areas appeared to be favorable for the introduction and establishment of wart, but the disease was not found.

It is hard to believe that wart in the United States is confined to the coal fields of Pennsylvania, Maryland, and West Virginia, yet all our evidence thus far points in this direction. Many millions of bushels of European potatoes were distributed in other regions, where conditions appear to be as favorable for the development of the disease as those in the three states named. It hardly seems possible that wart was absent in all the shipments going to

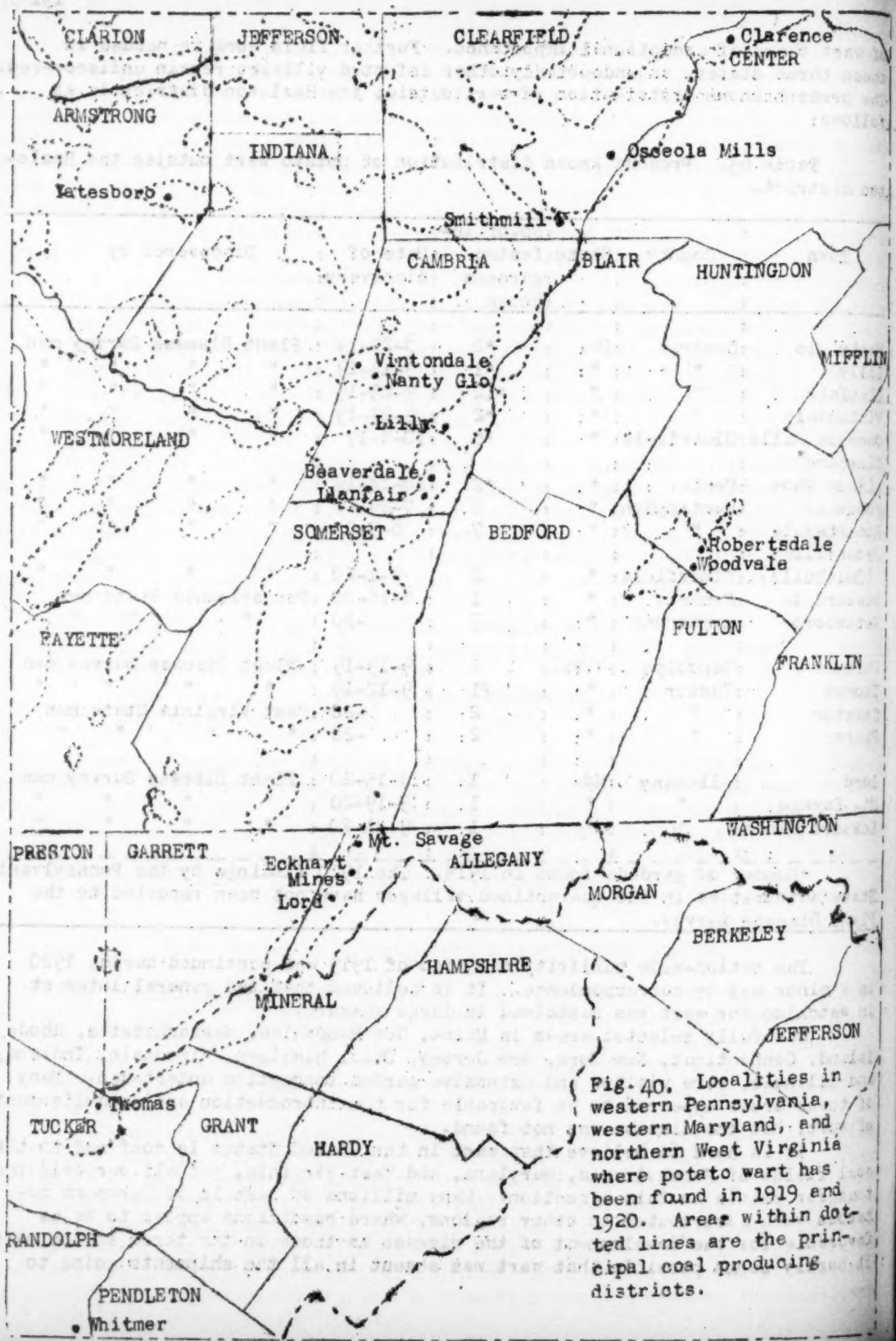


Fig. 40. Localities in western Pennsylvania, western Maryland, and northern West Virginia where potato wart has been found in 1919 and 1920. Areas within dotted lines are the principal coal producing districts.

other states, or that it failed to establish itself in all cases when present. However, we believe it can be stated with reasonable assurance, that there is no other large area of severe infestation comparable to the Hazleton district. We believe that such areas would have been located by the surveys of the past two years. Smaller areas, or those with slight infestation, might easily have been overlooked.

It appears from the work of the past year that we are not likely to find wart in large cities like New York and Chicago, even though vast quantities of foreign potatoes which may have carried wart were consumed there. This statement is based on the following observations: (1) Gardens are not common in foreign quarters of large cities, where the imported potatoes were largely consumed, and, where present, are small and usually contain no potato plants. (2) Garbage is usually collected by the city, domestic animals like chickens and pigs are not generally kept, and as a result garden sanitation is not favorable to the establishment of the disease. (3) In the environs of large cities, where gardens are more common, the people are usually more intelligent and conditions do not usually favor the disease.

The greatest danger points appear to be small, more or less isolated communities of foreigners, where there is room for gardens and where general surroundings are unsanitary. Mining villages present ideal conditions, but saw-mill villages and many of the smaller industrial communities would seem to be equally favorable.

Stem rot and scurf caused by Corticium vagum solani Burt.

This diesease, commonly spoken of as Rhizoctonia, doubtless occurred in all regions where potatoes were grown. Most of the collaborators that reported on the disease in 1920 mentioned that it was generally distributed with the crop. The sclerotia of the fungus are very common and traces of them can be found in almost any lot of seed or table potatoes one wishes to examine. Of course the abundance of the disease varied greatly in different localities, depending on climatic and soil conditions. Thus, in parts of Arkansas it is said not to be important as the soil is too acid, while in Ohio, on the contrary, it is reported as being especially bad on certain acid soils.

The recent work of Richards (Abstract in Phytopath. 11, January, 1921) has shown that soil temperature is a vital factor in determining the degree to which the potato may be damaged by Rhizoctonia. Temperatures of 15-21° C (59-69.8°F) are said to be optimum for the production of lesions on shoots and stems below ground. It is obvious then that variations in locality, date of planting, character of the season or any other circumstance influencing soil temperature, may have much to do with the degree to which the potato plant is damaged. In Wyoming, H. G. McMillan reported severe attacks of Rhizoctonia in places where the irrigation water was applied to early.

Rhizoctonia is classed among the more serious potato troubles, not because of its large and conspicuous local losses but because it causes damage everywhere. It is the aggregate loss for the country as a whole that places it among the major potato diseases. According to estimates of this office Rhizoctonia ranked fourth in importance of the potato diseases, both in 1918 and 1919.

The estimates of percentage loss from this disease for 1920 are given on the accompanying map - Fig. 41 (For loss in bushels and totals for the United States see Plant Disease Bulletin Supplement 18, 1921). The losses of 1920 were apparently somewhat in excess of those of the preceding year. Although the majority of the states indicated that the disease was about the same as last year, collaborators in Iowa and Utah reported less and those in North Carolina, Ohio, and Kentucky reported more.

Fig. 41. Estimated percentage reduction in yield of potatoes from Rhizoctonia, 1920.

A better idea of the importance of this disease can be gained from the following quotations from collaborator's reports:

Massachusetts (Osmun) - General and as prevalent as usual. New York (Chupp) - important. Same as last year and average year. Present in 95% of the fields, wherever potatoes are grown. New Jersey (Cook) - Present throughout the state. Losses much greater than supposed. West Virginia (Giddings) - Unimportant. Generally distributed in slight amounts. Kentucky (Valleau) - Very important in early crop killing growing points or girdling young plants. Present in all fields examined, affecting 8% of the plants and causing 5% reduction in yield of spring crop. North Carolina (Jehle) - Very important. All over state but very prevalent in Wayne and Transylvania Counties. Georgia (McClintock) - Slight, causing stem lesions and aerial tubers. Mississippi (Neal) About same. Of no importance. Arkansas (Elliott) - Trace of injury. Soil too acid. Ohio (Selby) - Prevalent and quite widely distributed, especially on late and medium late potatoes. Indiana (Gardner) -Same as last year. Very little in southern Indiana. Wisconsin (Vaughan) - As usual. One of the principal diseases. Is coexistent with the host causing reduced stands with a result that the crop is reduced 2%. Minnesota (Stakman) - Rather prevalent and destructive. In some fields as many as 25% of the plants were severely affected. Iowa (Melhus) - Less than last year, 2% loss. North Dakota (Bolley) - Very common throughout the state. Not always well controlled, even when seed tubers were properly treated. Utah (Richards) - Very important, less than last year. Occurred

throughout the state causing stem cankers. Idaho (Hungerford) - About same as last year. Important, present in all fields reducing the yield about 5%. Washington (Heald and Dana) - Reported from all parts of the state. Oregon (McKay) - Widespread in western Oregon causing, in combination with hot dry weather of August, the premature death of 10-30% of the plants. Very bad where rotation is not properly used. California (Smith) - Rhizoctonia, combined with the effect of prolonged cold and dryness, caused a serious set-back in early planted potatoes and other field crops. Many recovered and produced a good crop.

The season of 1920 was unusually backward over the greater part of the country. The months of June and July, when late potatoes were sprouting and coming through the ground in the late potato belt, were wet and abnormally cold. The weather records for July show that the temperatures were below normal in all states except North Dakota, Montana, Wyoming, Utah, Arizona, and all states west except California. In view of the temperature relations that have been demonstrated for Rhizoctonia it is quite probable that the subnormal July temperatures of 1920 favored the disease.

Dates of first appearance of Rhizoctonia on potato plants, 1920:

May	Louisville, Ky.	July	Texas
May 15	Jackson, Miss.	July 3	Nautoma, Wis.
May 24	Suffolk Co., N. Y.	July 28	Ohio
June 1	Corinna, Me.	August 4	Hennepin Co., Minn.
June 15	Utah		

Rural New Yorker. was less injured in Wisconsin than early varieties and Green Mountain, and in Wyoming the disease was noticed particularly on Triumph.

Considerable evidence is being accumulated to show that infection from the soil is not so important as infection from the seed piece. This is borne out by the success that has attended seed treatment. The following statement by H. L. Bolley of North Dakota points in the same direction:

> "This disease at digging time is found to be quite general throughout the state but evidently depends upon previous seed infection more than upon soil infection, for there are fields essentially free interspersed."

Good control by seed disinfection with mercuric chloride (1-1000 for 1-1/2 hrs.) is reported from Ohio, Indiana, and Wisconsin. Cooperative seed treatment experiments were conducted in Iowa, Minnesota, and Wisconsin in 1919 using -

(1) - Formaldehyde (1-240) cold for 2 hours.
(2) - Formaldehyde (1-120) 50° C for 2 minutes.
(3) - Copper sulphate (3-4000) for 2 hours.
(4) - Mercuric chloride (1-1000) for 1-1/2 hours.

The results, which were conflicting, may be summarized as follows: (I. E. Melhus. Cooperative potato seed treatment experiments (Committee Report) Phytopath. 11: 59, January, 1921).

Treatments listed in order of efficiency.

Iowa: Copper sulphate, hot formaldehyde, mercuric chloride.

Minnesota: Hot formaldehyde, mercuric chloride, copper sulphate.
Wisconsin: Mercuric chloride and hot formaldehyde about equal in efficiency, and copper sulphate poorest.

The cold formaldehyde (1-240) for 2 hours gave fair control at all stations.

Bacterial wilt caused by Bacillus solanœarum EFS

In North Carolina, the only state reporting losses due to bacterial wilt during 1920, the disease was said to be increasing in severity and importance in the Coastal Plains counties. The reduction in yield in the state was estimated at 3%. Bacterial wilt was reported also from Ohio as less prevalent than usual, and from Alabama.

The disease undoubtedly occurred in South Carolina, Georgia, and Florida, although no definite reports were received from those states in 1920.

Verticillium wilt caused by Verticillium albo-atrum Reinke & Barth.

Verticillium wilt was reported during 1920 from Ohio where it was found in Hardin County, August 5, and from western Oregon where it is always one of the serious potato diseases. The Oregon report would indicate that the disease was not so destructive as usual and that the loss in yield would approximate 3%. According to pathologists at the Agricultural Experiment Station the presence of the disease in Massachusetts is suspected.

Scab caused by Actinomyces scabies (Thax.) Güssow.

Common scab occurred generally with the potato crop in regions, localities and fields where soil and climatic conditions were favorable for the disease. It is a common experience to find scab much worse in some parts of a state than in other parts. Thus in 1920 it was reported as worse in the northern than in the southern parts of Indiana, and in the Marinette section of Wisconsin and on Long Island, New York the disease was negligible in quantity compared with many other parts of the same states. Records of other years have indicated this regional distribution within states for in 1918 Georgia reported scab worse in the northern counties and in 1917 and 1919 Idaho and Minnesota reported less in the northern than in the southern portions of those respective states.

Within a given section the amount of scab varies greatly, depending largely on the nature of the soil and the presence of the organism. The same thing applies to individual fields for it is very often found to be much worse in some parts of a field than in others. An examination of past reports to the Plant Disease Survey shows that collaborators have frequently mentioned that the disease was worse on the heavier and more poorly drained soils, as well as on those that have had applications of lime, ashes or stable manure or for some reason are alkaline. In Aroostook County, Maine the Caribou type of soil which is usually on the higher land and on the ridges, normally yields much less scab than the Washburn soil, which for the most part occupies the depressions and lower levels. According to H. A. Edson the hydrogen-ion concentrations of solutions from these two soils are considerably different and correspond with

the hydrogen-ion concentrations of solutions that will prohibit or permit the growth of the scab organism as the case may be. In Colorado H. G. McMillan reported very little scab except at the lower end of potato fields where the irrigation water is backed up.

Thus, although scab is a widespread disease and occurs to a greater or less extent in all parts of the country, it still is quite largely a local problem, important in some sections and not in others.

In 1920 scab was about as prevalent as last year and the average year although collaborators in Connecticut, Mississippi, and Iowa reported more than in 1919. The meager estimates of damage as furnished by collaborators for 1920 are given in Table 64.

Table 64. Injury and loss to potatoes from scab, 1920.

State	Percentage of injury	Percentage of loss	State	Percentage of injury	Percentage of loss
New York	3	0.3	Ohio	Small	
New Jersey	Heavy		Indiana	-	5% (in value)
Georgia	1	0.01	Wisconsin	4	.5
Texas	-	0.5	Minnesota	50	1
Mississippi	-	4-6	Iowa	-	6
Arkansas	5	-			

The requirements for U. S. Grade No. 1 potatoes call for tubers which are practically free from scab, meaning so free that, "the appearance shall not be injured to any extent readily apparent from a causal examination of the lot and that the damage can be removed by the ordinary process of paring without appreciable increase in waste over that which would occur if the potato were perfect". This requirement, together with those set up within the states for certified seed potatoes, make scab a more serious economic problem for the farmers who are trying to grow first class table or seed stock than in earlier years. The following instance quoted from a communication from F. C. Meier, August 26, illustrates this point:

> "Common scab is causing much trouble in the above mentioned territory (Redbank, New Jersey and vicinity). Our shipper claims to have had about 19 carloads rejected at destination on account of failure of stock to meet requirements of U. S. Grade No. 1 as regards common scab and second growths. This shipper went so far as to make the statement that, in his opinion, not more than 10% of the crop in some sections could be graded No. 1."

In order that we may have before us the data on losses, importance and relative prevalence by states the accompanying digest of all reports made to the Plant Disease Survey since its beginning has been prepared.

Importance of scab in various states as reported to the Plant Disease Survey:

Maine: 1907 - On the increase, especially in the best potato sections where they have not apparently recognized the importance of clean seed. There is much complaint from it this year and the subject demands serious attention from all growers. 1908 - Many reports, 5-10% injury. 1909 -

Usual amount. 1910 - Usual amount. 1914 - Generally distributed.

New Hampshire: 1906 - 20% crop injury. 1907 - 20% injury. 1909 - Less. 1917 - Less than 5% loss.

Vermont: 1906 - Apparently less than average. 1907 - Same. 1908 - Less than 1907. 1915 - Common, 15-20 injury. 1916 - Very abundant, 10-15% injury. 1917 - 10-15% injury, 5-10% loss. 1918 - 25% injury, 10% loss.

Massachusetts: 1905 - Not serious. 1906 - Quite serious. 1907 - More abundant. 1910 - Always present but never severe when seed is treated and no lime applied to soil. 1915 - Frequent, less. 1916 - Very small loss. 1917 - More common. 1918 - 3% loss. 1919 - 1% loss. 1920 - As usual.

Connecticut: 1915 - Negligible owing to acid soil. 1916 - Probably less. 1917 - As usual. 1918 - Probably 1-2% loss. 1919 - Probably less. 1920 - More.

New York: 1907 - Much worse. 1910 - But little. 1913 - Fairly common, loss small. 1914 - Common, 20-25% affected, 1% unsalable. 1915 - 5% injury, small loss. 1918 - 6% injury, 1% loss. 1920 - .3% loss.

New Jersey: 1905 - Much less than 1904. 1906 - More. 1912 - Very abundant. 1913 - Abundant. 1914 - Abundant. 1915 - As usual, 25% injury. 1917 - Same or less than usual. 1919 - More than usual. 1920 - Same, loss heavy.

Pennsylvania: 1908 - Same, 5-10% injury. 1909 - 5% injury. 1910 - 5% injury. 1911 - 5% loss. 1912 - 5% loss. 1914 - 25% injury, 3-5% loss. 1915 - As usual, 5% injury, less than 1% loss. 1917 - 10% depreciation. 1918 - 20% injury, 5-8% loss. 1919 - About as usual, 10-15% injury, 4-5% depreciation.

Delaware: 1907 - less than 2% injury. Not serious this year. 1912 - 1% injury. 1913 - 1% injury. 1914 - 1% injury. 1915 - Very common, 2-5% injury. 1916 - 1% injury. 1917 - 2% injury. 1918 - Same or less than 1% injury. 1919 - 4-5% loss in east.

Maryland: 1905 - Up to 25% injury.

Virginia: 1910 - 20% injury. 1912 - Usually very slight. 1915 - 5-25% injury.

West Virginia: 1914 - Slight. 1915 - Slight. 1917 - About 1% loss. 1918 - Slight. 1919 - Moderate, 10% injury, 2% loss.

Kentucky: 1915 - 1% local injury. 1917 - Quite prevalent in all fields, 10% injury.

Tennessee: 1919 - 50% injury.

North Carolina: 1905 - Less than 1904, 5% loss. 1912 - Loss very slight. 1913 - Loss moderate. 1915 - Moderate. 1916 - No appreciable damage, rare, loss negligible. 1917 - About 5% crop injury.

South Carolina: 1906 - Less. 1917 - 10-20% injury. 1918 - 30% injury, 2% loss. 1919 - Common, 10% injury, 1% loss.

Georgia: 1915 - Light. 1917 - 2-3% loss. 1919 - 2-10% loss. 1920 - Trace loss.

Florida: 1905 - Complete loss on 50 acres of limed land. 1907 - 5% crop attacked. 1914 - Same. 1917 - 5-10% loss, frequently 95% crop affected locally. 1918 - As usual.

Alabama: 1907 - 80% injury. 1918 - Very little. 1919 - Large loss, more.

Mississippi: 1909 - General. 1914 - Scarce, slight loss. 1919 - Common, probably 5% loss. 1920 - 4-6% loss.

Louisiana: 1910 - Very large loss in places. 1913 - Common, considerable loss. 1914 - Considerable loss. 1915 - Considerable. 1917 - One-third of crop seconds or culls in one parish. 1918 - Very common; about 5% loss. 1919 - Very common, probably 10% loss.

Texas: 1916 - 2% injury in east. 1917 - .5% loss. 1919 - Prevalent, 5% loss. 1920 - .5% loss.

Oklahoma: 1907 - Very prevalent, 5% injury. 1908 - 5% injury. 1916 - Very slight loss. 1917 - 2% loss. 1919 - Less than usual.

Arkansas: 1915 - Less. 1917 - 10% infected tubers. 1919 - 5% injury. 1920 - 5% injury.

Ohio: 1905 - More, 21% injury. 1906 - Less than 1905, 5% injury. 1907 - Less. 1908 - Less, 2% injury. 1914 - More reported. 1915 - Less than 1914. 1917 - About 15% loss. 1919 - More than 1918. 1920 - Loss small.

Indiana: 1905 - 15% injury. 1907 - 10-20% injury. 1908 - 25% injury. 1910 - 15% injury. 1915 - 2-50% injury. 1917 - 3% loss. 1920 - 5% loss in value.

Illinois: 1911 - Injury small. 1912 - Well controlled in commercial sections. 1917 - 10-15% loss.

Michigan: 1912 - Whole state badly infested, 5% crop thrown out. 1913 - 5% loss, 90% in one field. 1914 - Everywhere, 5-10% loss with deep scab. 1915 - As usual.

Wisconsin: 1914 - Small injury, 1-5% loss. 1915 - Little, 3-4% injury. 1916 - More than for several years. 1917 - Less than 1916, small loss. 1918 - Small loss. 1919 - 3% loss. 1920 - As usual, 4% injury.

Minnesota: 1906 - 5% injury. 1908 - Considerable damage. 1915 - Average amount. 1916 - More than 1915, 5% injury. 1917 - Less. 1918 - Less than usual, about 1% loss. 1920 - Same as 1919, 1% loss.

Iowa: 1904 - Great deal. 1905 - Prevalent, 4% injury. 1906 - Same. 1907 - Same. 1910 - 5% injury. 1913 - Abundant. 1914 - Abundant. 1915 - Abundant. 1916 - 1% injury. 1917 - 3% injury. 1919 - More, 12-20% damage. 1920 - More, 6% damage.

Missouri: 1918 - Common, 15% injury. 1919 - Slight to moderate.

North Dakota: 1907 - Less common. 1908 - Less. 1913 - Not common. 1915 - Less than 1914.

South Dakota: 1913 - Common. 1914 - Bad. 1915 - Same, 10% injury. 1917 - More. 1919 - 25% injury, 5% loss.

Nebraska: 1903 - Very common in some parts of state. 1904 - Occurs in all parts of state and in counties on Missouri River (Sarpy and Nemaha) a damage of from 10-15% is reported. 1906 - 15% injury. 1915 - Same as 1914, 5-10% injury. 1919 - 5% loss.

Kansas: 1915 - Very little noted; injury negligible.

Montana: 1903 - Found in many parts of state but not considered dangerous. 1917 - Average prevalence.

Wyoming: 1915 - General, 50% injury.

Colorado: 1915 - All over state, worse in irrigated fields. 1917 - One of the important diseases.

New Mexico: 1915 - 2% loss. 1916 - 1-10% loss. 1917 - 10-20% loss.

Utah: 1912 - Very bad in some cases. 1915 - Not quite as abundant as usual, 20% injury. 1917 - Not common.

Nevada: 1915 - 25% injury. Worst on heavily irrigated areas. 1919 - 2% loss.

Idaho: 1913 - 1-100% injury, very prevalent. 1915 - Generally prevalent, 1-100% injury. 1916 - Bad in places. 1919 - 10% injury, 2% loss. 1920 - About same, important.

Washington: 1903 - General but loss not large. 1907 - Injury up to 100%. 1908 - Common, 5% injury. 1917 - 5-10% loss and 10-20% reduced to second grade.

Oregon: 1909 - Serious locally. 1911 - Common but not serious except locally. 1915 - Common everywhere. 1917 - Not very serious loss.

California: 1910 - Fairly serious. 1917 - Common but not serious.

Among other things an examination of the preceding data shows that not only is the disease generally distributed over the United States, but (1) that it is much more of a problem in some states and in some localities than in others, (2) that the average state losses in general are not especially high although the percentage of injury is in many cases, and (3) that the disease varies considerable from year to year, apparently being influenced by the season.

Potato varieties differ in their susceptibility to scab. Lutman (Resist-

ance of potato tubers to scab." Vermont Agr. Exp. Sta. Bul. 215. 1919) has shown recently that the true russet types of tubers show marked resistance while the semi-russets show some scab resistance, and the white, thin-skinned varieties seem most susceptible. He has demonstrated that resistance is correlated with thickness of skin, tubers that have the thinnest skin being the most susceptible. The following list gives the named varieties that Lutman used in 1917 arranged in order of their resistance to scab, the most resistant given first and the most susceptible last.

Table 65. Potato varieties arranged in order of resistance to scab according to B. F. Lutman's experiments, 1917.

Variety	Percentage clean tubers 1917	Variety	Percentage clean tubers 1917
Cowhorn	60.	Early Rose	17.5
Burbank's Russet	57.5	Bovee	12.1
Scab Proof	55.9	Green Mountain	7.4
Cambridge Russet	36.2	Reading Russet	.8
Dibble's Russet	22.9	Ninety-fold	.7
Sir John Llewellyn	19.6		

In Plant Disease Survey collaborator's reports since 1903 a number of varieties have been mentioned as resistant or susceptible as shown in Table 66.

Table 66. Susceptibility of potato varieties to scab as shown by collaborators' reports, 1903-1920.

Susceptible varieties	Resistant varieties
Early Rose - Pennsylvania, 1913	Netted Gem - Idaho, 1915
Early Ohio - Minnesota, 1919	Rural New Yorker - Wisconsin, 1918-1920
Green Mountain - Wisconsin, 1915	Russet Burbank - Minnesota, 1917
Rehobeth - Maryland, 1915	Irish Cobbler) (Montgomery County,
Early varieties in general - Wisconsin, 1919	Crown Jewel) (Maryland, 1908

The value of seed treatment in the control of scab has been demonstrated in many different places, but there are also many sections, particularly the older ones, where seed treatment appears to be of little value. The discussion on potato diseases at the Chicago meeting of the American Phytopathological Society, December 30, 1920 brought out the fact that seed treatment is not established in many of the great potato growing sections and that the principal reason seems to be that the growers do not find that it pays them. The case was cited of Aroostook County, Maine where farmers have watched the results of seed treatment for years but still have not yet considered the practice commercially profitable. As already stated, these growers have practically no trouble with scab on what is called the Caribou soil, and it is on this that most of the potatoes are grown, but they do suffer heavy losses on so-called Washburn loam and it seems to make little difference whether or not the seed is treated.

Hot formaldehyde (2 pints to 30 gallons - 2 minutes at 118-122° F) has

probably been used more in Iowa during the past year than ever before and it is being employed some in other states. In New York, for instance, it has been met with favor by a number of farmers and it is expected by New York collaborators that its use will increase. On the other hand many states still prefer corrosive sublimate as a general disinfectant for seed-borne diseases of the potato.

During the last two years progress on cooperative community seed treatment work has been made in Iowa (Porter, H. R. Cooperative seed treatment using hot formaldehyde. Abstract Phytopath. 11: 59. 1921). Hot formaldehyde was employed with favorable results some of which are given in Table 67,

Table 67. Some results of seed treatment with hot formaldehyde, Iowa, 1919-1920.

Year	Number of fields	Percentage of infected tubers: Seed treated	Seed not treated
1919	4	15	76
1920	4	33	68

Results with the use of inoculated sulphur have been reported from New Jersey[1] and Wisconsin[2] during the past year. In New Jersey sulphur flour inoculated with soil well supplied with sulphofying organisms gave better scab control when applied to the land than did the sulphur flour alone. In Wisconsin, where a commercial inoculated sulphur was used, the results were not successful.

Mosaic (cause undetermined)

Mosaic is distributed widely all over the country where susceptible varieties are grown. In 1920 it was reported from practically all states. In most of these it occurred in about the same amounts as usual although collaborators in Massachusetts, Connecticut, and Idaho estimated somewhat more the last year. In Alabama A. F. Thiel reported that some fields in Mobile County, which showed heavy infection in May recovered considerably with the result that the ultimate loss was negligible. Observations along similar lines are reported by R. E. Vaughan from Wisconsin, September 1 as follows:

> "The mosaic which showed up earlier in the season has been largely masked by dry weather and development of the vines. Late planted Triumphs have much more mosaic than early planted, showing the importance of environment in the severity of this trouble."

B. F. Lutman, on October 15, stated that the loss from Mosaic would be smaller than usual on account of the cool, rainy season.

The mosaic situation in the western states is summarized by Mr. M. Shapovalov of the Office of Cotton, Truck, and Forage Crop Disease Investigations, who examined fields extensively in many of the important potato sections of the West during July, August, and September, 1920. He has contributed the following:

> "Mosaic appears to be common in all western states. Its symptoms sometimes are obscure, but on close examination it could be detected on

1. Martin, W. H. Inoculated vs. uninoculated sulphur for the control of common scab of potatoes. (Abstract) Phytopath. 11: 58. 1921.
2. Vaughan, R. E. Inoculated sulphur for potato scab control. (Abstract) Phytopath. 11: 58. 1921.

the foliage in every locality visited. It is fully recognized in Wisconsin and Minnesota as an important problem, but it presents practically an untouched field farther west. An adequate study of it there is very urgent in order to find out (a) the actual reduction of yields, (b) the rapidity of its spread during the season, and (c) the deterioration of the stock in the course of a number of successive seasons. Judging from the basis of our experience in the East, and considering the condition of the potato fields in the West, this year we may expect that a substantial increase in production can be secured through a more vigorous extermination of the mosaic-infected hills."

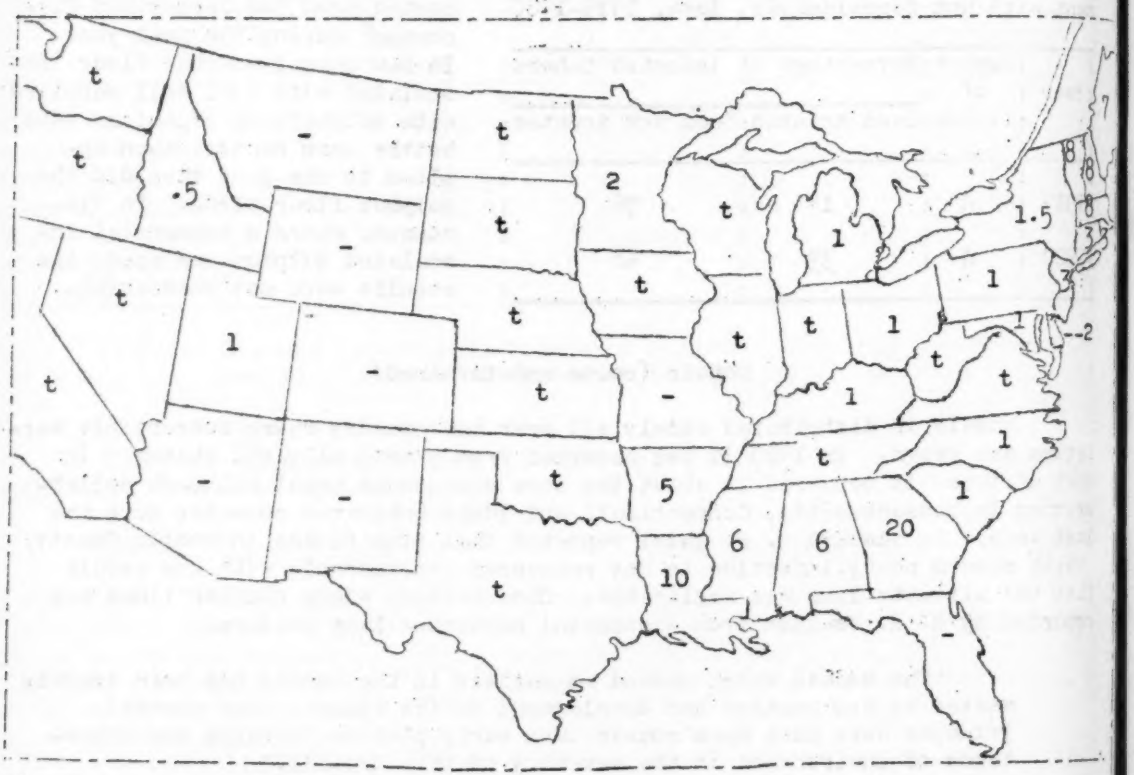


Fig. 42. Percentage reduction in yield of potatoes from mosaic, 1920. (For final estimates and loss in bushels see Supplement 18, 1921.)

Mosaic is the cause of very heavy losses to varieties that are susceptible, especially the Triumph and Green Mountain. In states where these varieties are largely grown, such as New England, New York, and the early trucking sections of Georgia, Alabama, Mississippi, and Louisiana, the disease becomes very important from the economic standpoint. In Michigan, Wisconsin, and Minnesota it is said to be very important on Triumph wherever it is grown.

The above map shows the estimated percentage loss by states and Table 68 gives other data bearing on the percentage of infection.

In New York and Pennsylvania a large number of counts were made of the percentages of mosaic in connection with seed potato inspection and certification work. Some of the results by counties are given in Table 69.

Table 68. Percentages mosaic affected plants and losses as given by a number of states.

State	Per cent affected plants in state	Estimated reduction in yield	Highest percentage found in any one field.
New Hampshire	-	8	100
Vermont	25-50	8	-
New York	4.42	1.5	90
Kentucky	-	1	60
Tennessee	-	t	40
Mississippi	-	6	100
Alabama	25-50	6	100
Arkansas	15	5	-
Wisconsin	2.5	t	90
Minnesota	9.5	2	50

Table 69. Percentages of mosaic in potato fields inspected in New York and Pennsylvania, 1920.

State	County	Number of fields inspected	Acerage	Average percentage mosaic
New York	Allegany	26	55.00	1.75
	Cayuga	18	43.00	6.00
	Cherango	9	27.00	18.07
	Clinton	34	110.25	15.64
	Cortland	58	195.69	1.52
	Erie	12	60.75	1.82
	Essex	5	17.50	5.04
	Franklin	27	121.75	11.67
	Genesee	11	54.20	0.23
	Jefferson	2	3.50	0.00
	Livingston	9	25.00	1.37
	Monroe	18	57.45	0.54
	Orleans	23	88.75	0.47
	Oneida	15	38.20	1.45
	Onondaga	36	105.10	5.22
	Ontario	19	57.65	1.38
	Oswego	25	66.75	15.74
	Rensselaer	2	10.50	0.48
	Seneca	14	26.25	0.11
	Steuben	13	58.50	0.92
	Washington	47	115.86	3.70
	Wyoming	18	63.00	0.89
Total and average		440	1391.65	4.42
Pennsylvania	Cambria	175	617.00	8.20
	Lehigh	207	1524.00	2.10
	Potter	139	454.00	11.00
Total and average		521	2595.00	3.90

Dates of first appearance of mosaic, 1920.

March	Baton Rouge, La.	June 21	Suffolk Co. N. Y.
May	Alabama	June 22	Bremford, Conn.
May	Griffin, Ga.	July 15	Milton, N. H.
May	Arkansas	July 22	Sherbourne Co. Minn.
May 15	Crystal Springs, Miss.	July 25	Rhinelander, Wis.

The data that has been received on varietal resistance can best be summarized by quoting directly from collaborators' reports.

New Hampshire: "Especially prevalent on Green Mountain." (Butler)

New York: "Especially on white sprout varieties." (Chupp)

New Jersey: "Common on Giants, Green Mountains and in some cases on Jersey Red Skins." (Cook)

Pennsylvania: "Green Mountain and Spaulding Rose susceptible." (Thurston and Orton)

Kentucky: "Carmans practically a failure. Green Mountains and Cobblers seem fairly free probably due to tuber unit selection on part of a few growers of seed." (Valleau)

Georgia: "Observed on 90% of the Red Bliss (Triumph) planted as a spring crop and on 2% of the McCormicks planted as a late crop. Also observed on Green Mountain. Cobbler, Early Ohio, and Early Rose were quite free from mosaic in spring crop." (McClintock)

Alabama: "Triumph always heavily diseased." (Thiel)

Mississippi: "Bliss Triumph most susceptible." (Neal)

Louisiana: "Severe on Triumph. Not so important on other varieties." (Edgerton)

Indiana: "Tippecanoe County - on three plants of Rural New Yorkers. DeKalb County - bad on Early Ohio. Floyd County - bad, 100% incidence, on Bliss Triumph." (C. T. Gregory)

Michigan: "Very serious on Bliss (Triumph) in Upper Peninsula - serious on Green Mountain. Of minor importance on Rural types." (Coons)

Wisconsin: "Hardly a field of Triumph but what will show some mosaic. Fields from the stock of J. W. Smith, Kent, Langlade County, Wisconsin are remarkably free. Rural New Yorker free." (Vaughan)

Minnesota: "More common on Triumph, next Green Mountain and rare on other varieties." (Section of Plant Path.)

Leaf roll (cause undetermined)

Leaf roll was reported from most of the states east of the 100th meridian and from Idaho, where it was most common in the north, and from the Palouse

country of Washington. In most states the disease seemed to be of comparatively slight importance but Kentucky lists it as the most important potato disease and Pennsylvania regards it as second only to late blight in destructiveness. In New York it is a very important trouble in the "blue sprout" area of the western part of the state and in Vermont it was the third most important potato disease in 1920. In the West leaf roll was not at all abundant, but was noticeable locally in many states. Losses were reported by states as follows:

Table 70. Percentage losses from leaf roll of potato, 1920.

Percent loss	States
10	Pennsylvania.
5	Kentucky and Georgia.
2	Maine, Vermont, New Jersey, Maryland, Virginia, West Virginia, Ohio, and North Carolina.
1.5	New York.
1	New Hampshire, Massachusetts, Rhode Island, Connecticut, and Illinois.
Trace	Other states.

An idea of the situation in Pennsylvania may be gained from reports received from that state August 1 and October 15, 1920.

> "E. L. Nixon, who is continually in the field and spending his time largely on work with potato diseases, reports that the average amount of leaf roll for all fields in the State will approximate 20%. This is the most important potato trouble, except late blight in Pennsylvania. Careful rogueing of fields for seed is having pronounced effect in reducing this percentage.
>
> "Professor Nixon reports that seed free from this disease has uniformily resulted in an increase in yield of 25%. He bases his report on the results of his demonstrations in over 15 counties, where clean seed was planted side by side with the farmer's field run seed." (H. W. Thurston)

The situation at Bardstown, Kentucky has already been reported (Pl. Dis. Bul. 4: 51, Aug. 15, 1920). Mr Valleau has also sent in a supplementary report:

> "The occurrence of this type of leaf roll was previously reported to the Survey. It is characterized by very vigorous and erect growing plants, upward rolling of leaves, the extent of rolling indicating the extent of the injury to tubers, production of shorts growing up between the rows in place of tubers, or long stolons bearing several tubers of small size. It is carried in the seed potatoes from infested fields. It may cause complete loss when apparently normal northern grown seed are used."

As high as 90% infection was noted in a field in New York during the season; 100% was seen in Pennsylvania; 93% in Kentucky; and 50% in Indiana. The dates on which the disease was first observed are:

May ..... Crystal Springs, Mississippi.
June ..... Griffin, Georgia.
June 16 ..... Bardstown, Kentucky.
June 28 ..... Albany, Orleans, and Steuben Counties, New York.
July 14 ..... Ohio.
July 15 ..... Milton, New Hampshire.
July 28 ..... Beltrami County, Minnesota.

Leaf roll was mentioned as being especially bad on potatoes of the Rural group in New York and Pennsylvania. In New Jersey it was most common on Cobbler. There are a few strains of Rural in New York that are almost free from leaf roll.

A noticeable reduction in the amount of leaf roll in New York occurred according to the following statement:

"Much more certified or disease free seed is used. Therefore, leaf roll has a much lower average. Seneca County is a good example. During 1920 all the inspected fields were planted with Gibbs' stock - one of the best in the State." (Chupp).

Tip burn (non-parasitic) and hopper burn induced by leaf hoppers.

The form of tip burn caused by the direct effect of the sun on the leaves seemed to be much less abundant than usual last year owing to the cool and moist weather that characterized much of the growing season. Regarding this trouble B. F. Lutman in Vermont says:

"Much less important than usually. Would estimate that in the Champlain Valley that the potatoes had lost 40-50% of their foliage, September 1 by tip burn in average years; this year not more than 15-20%. No tip burn locally of any importance before about August 20, but made rapid progress for a few days then."

The hopper burn which seems to be especially bad in the Great Lakes States was also of less importance generally. Thus, in Michigan the statement is made that hopper burn was less serious than for the past five years and C. W. Waid says that it was widely scattered but did not prove as serious in 1920 as during the two previous seasons.

In Minnesota, on the other hand, hopper burn was very important, as it was last year and worse than the average. It affected about 80% of the plants in the state and caused a loss of about 1% of the crop. Other losses that have been estimated for tip burn are given in Fig. 43.

Dates of first reports, 1920:

June ..... Starkville, Mississippi.
June 29 ..... Hennepin County, Minnesota.
July 10 ..... Randolph County, Vermont.
July 10 ..... Michigan.
September ..... Ohio.

That Bordeaux mixture has some beneficial effect but does not control is the opinion of collaborators in Indiana and Michigan.

The Late Petoskey which is so generally grown in the Lower Peninsula of Michigan seems to be quite resistant to hopper burn according to C. W. Waid.

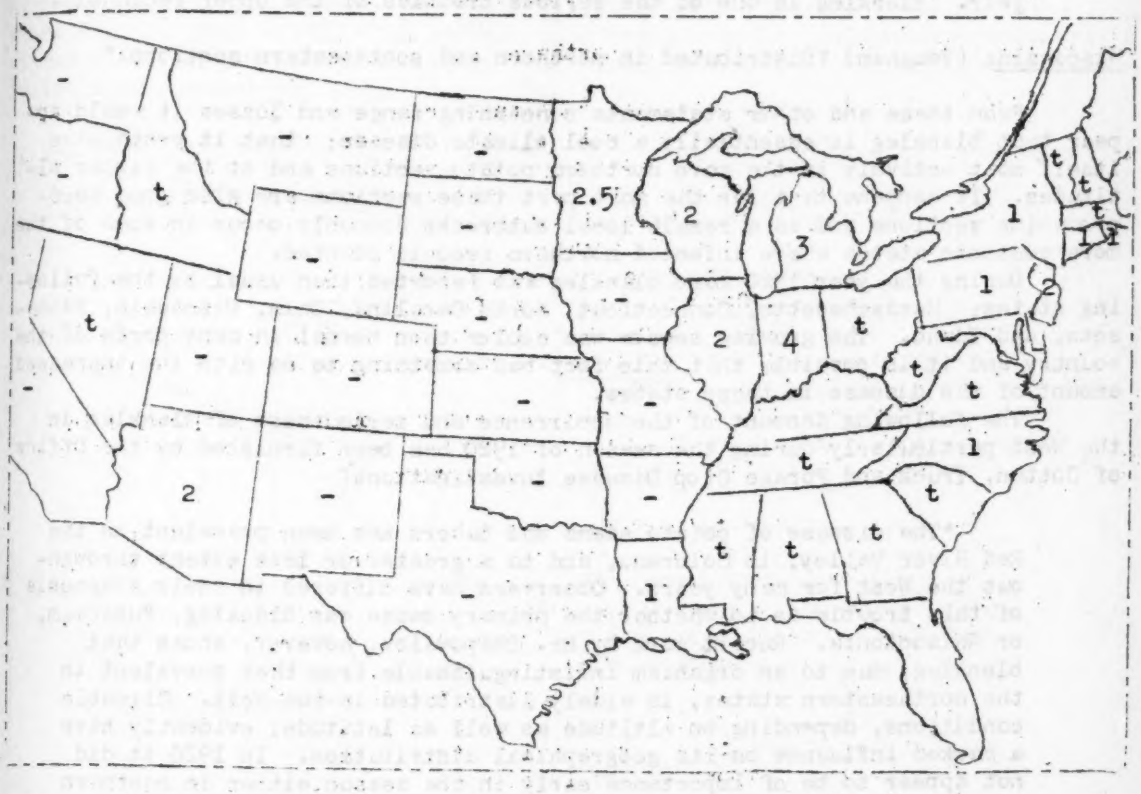


Fig. 43. Percentages loss from tip burn and hopper burn of potato, 1920. (For corrected figures see Pl. Dis. Suppl. 18, 1920.)

Blackleg caused by Bacillus phytophthorus Appel.

During 1920 blackleg was reported from the majority of states in the northern half of the country. Regarding the distribution of the disease within the states the following has been reported by collaborators and others:

New Hampshire: (Butler) "Present in small amounts in the fields of the northern counties; rare in the southern part of the state."

Virginia: (Fromme) "Reported as rather severe from trucking sections around Norfolk and Eastern Shore."

West Virginia: "Very prevalent in some of the higher sections of Tucker County."

Michigan: (Coons) "J. E. Kotila reports disease common and very persistent in the Upper Peninsula. I am figuring the loss as 5% for that district. I figure the loss from the Lower Peninsula as a trace."

(C. W. Waid) "Mr. E. B. Moore reports that he found considerable blackleg in Cass and adjacent counties. This seems to be the chief out-

break of the trouble in the Lower Peninsula. Some seasons we have found quite a good deal in the upper counties but it did not develop much this year. Blackleg is one of the serious troubles of the Upper Peninsula."

Wisconsin: (Vaughan) "Distributed in northern and southeastern sections."

From these and other statements concerning range and losses it would appear that blackleg is essentially a cool climate disease; that it propagates itself most actively in the more northern potato sections and at the higher altitudes. It happens that for the most part these sections are also good seed-producing sections and as a result local outbreaks commonly occur in some of the more southern states where infected northern seed is planted.

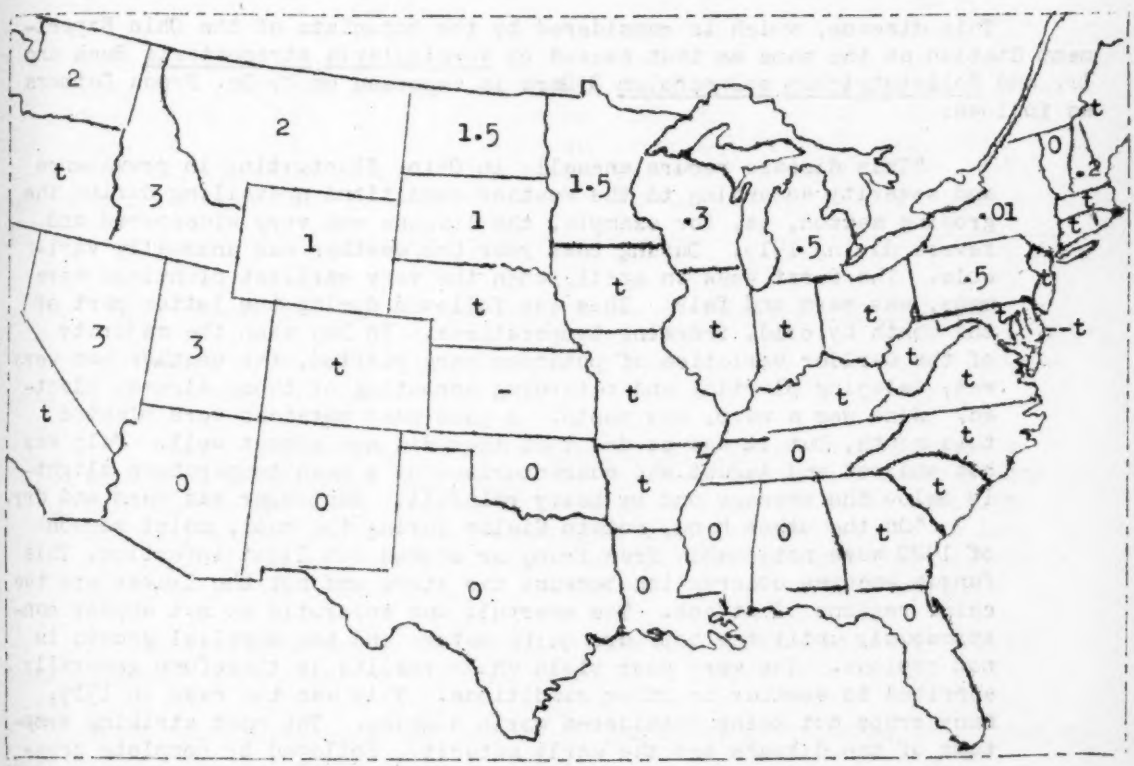
During the year 1920 more blackleg was reported than usual by the following states: Massachusetts, Connecticut, North Carolina, Ohio, Wisconsin, Minnesota, and Idaho. The growing season was cooler than normal in many parts of the country and it is possible that this fact had something to do with the increased amount of the disease in these states.

The following account of the occurrence and seriousness of blackleg in the West particularly during the season of 1920 has been furnished by the Office of Cotton, Truck and Forage Crop Disease Investigations:

"The disease of potato stems and tubers has been prevalent in the Red River Valley, in Colorado, and to a greater or less extent throughout the West for many years. Observers have differed in their diagnosis of this trouble as to whether the primary cause was blackleg, Fusarium, or Rhizoctonia. Recent work by Mr. Shapovalov, however, shows that blackleg, due to an organism indistinguishable from that prevalent in the northeastern states, is widely distributed in the West. Climatic conditions, depending on altitude as well as latitude, evidently have a marked influence on its geographical distribution. In 1920 it did not appear to be of importance early in the season either in northern Wisconsin or northern Minnesota, but it was very much so in the Red River Valley and in Montana, Washington, and northeastern and southeastern Idaho, especially at higher altitudes. Up to the middle of September its occurrence had been quite insignificant in central and southern Idaho and none had been seen in Utah although it was said to have been found there. In sections of Colorado it was quite serious, especially in the San Luis Valley. It occurs throughout the Greeley district and in Wyoming and Nebraska, but has not yet appeared there as a serious factor. Only one well known case was found in which the disease had persisted in locally grown seed over a period of years. It may be that the disease is introduced mainly through seed brought from eastern or northern seed-producing centers. It has been reported from western Oregon and probably occurs in California. During the summer blackleg appears mainly as a stem rot, the infection apparently spreading throughout the season in some irrigated sections. The tubers often show browning of the vascular ring, and in localities favorable to the disease it takes the form of tuber rot, which in external appearance sometimes resembles Fusarium stem-end rot or jelly-end rot."

Blackleg was not important in the East except in local fields, but in the West as indicated in the above quotation it was serious in some states. Thus, in Minnesota it was "common and widespread, affecting 15% of the plants in some fields". In the Upper Peninsula of Michigan an estimated loss of 5% took place. In Utah the disease was estimated as present in 75% of the fields

of early potatoes, affecting about 5% of the plants in those fields and causing a loss of approximately 3% for the state. The greatest amount of disease found in any one field was reported by states as follows: New Hampshire - 4%, Minnesota - 15%, New York - 5%, West Virginia - 5%, Wisconsin - 25%, Missouri 2%, and Utah - 35%. The accompanying map gives the preliminary estimates of reduction in yield from blackleg. For final estimates see Plant Disease Bulletin Supplement 18, 1921.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failure with seed treatment were reported, but it is probable that in these cases the methods employed were not the best.

Anthracnose caused by Colletotrichum atramentarium (Beck & Br.) Taub.

This disease, which is considered by the botanists of the Ohio Experiment Station as the same as that caused by Vermicularia atramentaria Beck and Br. and Colletotrichum solanicolum O'Gara is reported on by Dr. Freda Detmers as follows:

"This disease recurs annually in Ohio, fluctuating in prevalence and severity according to the weather conditions prevailing during the growing season, as, for example, the disease was very widespread and severe during 1919. During that year the weather was unusually variable. The first week in April, when the very earliest plantings were made, was warm and fair. This was followed during the latter part of the month by cold, freezing temperatures. In May when the majority of the earlier varieties of potatoes were planted, the weather was very wet, delaying planting and retarding sprouting of those already planted. June was a warm, dry month. A good many potatoes were planted this month, but it was so dry that they did not sprout well. July was hot and wet and August was characterized by a mean temperature slightly below the average and by heavy rainfall. September was warm and dry.

"On the other hand, potato fields during the cool, moist season of 1920 were noticeably free from, or showed but light infection. This fungus escapes observation because the stems and not the leaves are the chief regions of attack. The acervuli and sclerotia do not appear conspicuously until the tops are quite mature and the mycelial growth is not copious. The very poor yield which results is therefore generally ascribed to weather or other conditions. This was the case in 1919, many crops not being considered worth digging. The most striking symptoms of the disease are the early maturity, followed by complete prostration and drying of the tops, the stems frequently becoming white and dry as tinder. No visible infection of the tuber occurs. The injury to the crop is due to the reduction of yield both in size of the individual and in number of tubers. Infection seems severe in the early and medium late maturing varieties."

Jelly end rot probably caused by Fusarium sp.

This rot was reported on Netted Gem potatoes from southern Idaho where it was apparently the cause of less damage than last year. The disease was also found in a few fields in Monmouth County, N. J. by F. C. Meier and a report of occurrence has been received from Ohio.

Bureau of Market inspectors found potatoes with jelly end rot as set forth in Table 71.

Table 71. Percentages of jelly end rot found in individual cars of potatoes inspected during 1920.

State	Date	Number of cars	Percentage jelly end rot	State	Date	Number of cars	Percentage jelly end rot
Calif.	Feb. 5-6	2	1-4, 1-4	Ida.	Feb. 2-4	2	10-15, 5-8
	Feb. 7-16	5	10,4, 4, 3-4,3		Mar. 17	1	30-35
					Nov. 9	1	2-4
	Feb. 10	1	6		Dec. 17	1	2
	Mar. 4	1	10-12	Kans.	Feb. 5	1	3-4
	Oct. 26-30	2	5, 5	Minn.	Jan. 30	1	2-3
	Nov. 12	2	2,2	Wash.	June 1-3	2	15, 20
	Dec. 2-15	2	5, 2		Nov. 1	2	4-6, 5
Colo.	Nov. 12	1	1-2				

Leak caused by Pythium debaryanum Hesse or Rhizopus nigricans Ehr.

The Office of Cotton, Truck and Forage Crop Disease Investigations reports on this disease as follows:

> "Leak, due in large part to Pythium debaryanum, but to some extent also to Rhizopus nigricans, has occurred in western Idaho fields this summer and probably also in eastern Oregon. In these districts not only wounded tubers but sun-scalded potatoes are subject to infection. It is the early shipments of potatoes in which the principal losses from leak occur."

It was also reported as occurring in the field in Washington and was found by market inspectors as shown in Table 72.

Table 72. Percentages of leak in shipments of potatoes as determined by inspectors of the Bureau of Markets, 1920.

State	Number of cars	Average percentage of decay	State	Number of cars	Average percentage of decay
California	4	5	*Minnesota	5	4.3
Colorado	12	3	Wyoming	8	4.6
Idaho	16	3.3			

* The cause of leak occurring in Minnesota potatoes is questionable.

Other diseases.

Powdery scab caused by Spongospora subterranea (Wallr.) Johnson was reported once from each of three states: Hamilton County, New York, September 30; St. Louis County, Minnesota, in December; and Pierce County, Washington.

Southern blight caused by Sclerotium rolfsii Sacc. was reported from Mississippi and Texas. In the latter state it was thought to be more prevalent than last year.

Table 73. Percentages of Sclerotium rot caused by Sclerotium rolfsii as found by inspectors of the Bureau of Markets, 1920.

State	Variety	Date	Number cars	Percentage Sclerotium rot
Alabama	Spaulding Rose	June 19-21	5	14.4
Florida	" "	June 23-25	4	15
Georgia	-	June 21	1	4
Louisiana	-	June 14	2	19
North Carolina	Cobblers	June 21-July 8	4	6
Virginia	-	June 24	2	Occurred

Skin spot, uncertain cause, but said to be associated with Oospora pustulans Owen & Wakef. was found on British Columbia potatoes in the State of Washington, and was also found by market inspectors at Chicago on Canadian potatoes. When reporting this trouble and sending specimens to the Plant Disease Survey, F. D. Heald wrote:

> "This trouble is described in Bulletin 8 of the Royal Botanical Garden, Kew, England, which was issued just last year. These specimens are from our identification No. 2210, and originated from a carload of Gold Coin potatoes that was shipped into Spokane from British Columbia. So far as I know it is the first definite record of this disease from America, although Güssow apparently found what was the same trouble in Canada, but did not recognize it as of definite fungus origin. (See note and illustration in Phytopathology 8: 492-493, 1918). We have thus far no record of the occurrence of "skin spot" on potatoes in the United States, but this is not the first time it has come over from Canada. The disease was also abundant on some Scotch potatoes brought in for experimental purposes by the Pennsylvania Department of Agriculture. It is a trouble that should be watched, as, although it is classed as a minor disease, the disfiguration of the tubers is sufficient to materially impair their commercial value."

Silver scurf caused by Spondylocladium atrovirens Harz. - definitely reported only from South Dakota, Idaho, and Washington, but known to be common in many parts of the United States.

Violet root rot caused by Rhizoctonia crocorum (Pers.) DC. was reported from Thurston County, Washington.

Root knot caused by Heterodera radicicola (Greef) Mill. Reported by collaborators from Arkansas (common, 15% injury) and Nevada (4% reduction in yield, some benefit by planting clean seed on new land) and by the Office of Cotton, Truck and Forage Crop Disease Investigations from the West as follows:

> "The parasitic nematode, Heterodera radicicola, occurs very extensively in the warmer districts of the Southwest, throughout the valleys of California, in Nevada, and locally elsewhere. The potato is quite susceptible to this nematode and is one of the most dangerous carriers of the parasite. The fact must therefore be considered in all crop rotation plans, and cultivation of potatoes in nematode-infested soils limited or temporarily abandoned until the infestation can be reduced by

rotation with nematode-immune crops. The problem is really much more serious than we now realize, since it affects the culture of nearly all vegetables and most of our fruits."

Slimy soft rot (bacterial) Was very common as usual in potato shipments, particularly those from the South.

Curly dwarf, cause undetermined, was reported from New Hampshire, Iowa, and Washington. Three per cent reduction in yield is estimated for Iowa from this disease. Whether the disease is distinct from mosaic dwarf in all of these cases remains to be determined.

A dwarfing, probably related to mosaic or leaf roll, was important in a few counties in New York according to Charles Chupp. As high as 60% was found in one field and from 1 to 5% occurred in three counties. It is thought not to be the regular curly dwarf but it is characterized by sessile tubers, persistent seed pieces, and hard, brittle, internally-discolored young tubers.

Streak, cause undetermined, was reported from New York, Georgia, and Washington. In New York it is thought that trace of streak may have existed in nearly every county but it was observed as common in only one field at Granby, August 8. In Georgia what appears to be streak was seen on both Rose and Cobbler varieties. The disease that was reported as streak in Idaho last year is given this year under the heading of russet dwarf.

Russet dwarf, cause undetermined, which was reported from Idaho last year as "streak" occurred again in that state in 1920. The symptoms of this disease do not agree with those given by Orton. It causes a russeting of the leaves, blackening of the vascular system, and a dropping of the lower leaves. According to Hungerford the disease is very serious in southern Idaho.

Dodder (Cuscuta sp.) reported from Washington.

Alkali injury - reported from Washington.

Nut grass injury, caused by a species of sedge, Cyperus sp. boring into the tubers, was reported from Milford, Connecticut.

Thumb-nail cracking (non-parasitic) was much more prevalent on harvested tubers than usual in Minnesota. Observed mostly on Early Ohio and less on Irish Cobbler.

Black heart (non-parasitic) was observed in a number of carlots by market inspectors during 1920. Definite reports were received as follows:

January 10 ... Minnesota potatoes at Kansas City, 30-40% in one car 40-50% in another.
March 20 ..... Maine potatoes at New York, 40% in one car.
April 2 ..... Maine Triumphs at Philadelphia, 50-65% black heart in top layer and 10% in 5th layer.
October 4 .... Colorado potatoes at Memphis, 5-10% black heart.

Hollow-heart (non-parasitic) reported by market inspectors in potatoes shipped from the following states:

Table 74. Percentages of hollow-heart found in carlots of potatoes from various states, as reported by inspectors of the Bureau of Markets, 1920.

State	Percentage Hollow-heart	State	Percentage Hollow-heart
Colorado	5-10, 5-10, 5-10	Montana	10-12, 8-10, 10, 8,
Michigan	2-4, 2-3, 5, 8-10, 8, 5, 5-6, 6, 3-4.		8-10.
		Pennsylvania	10-70, 35, 25, 20.
Minnesota	12-18, 10-25.	Wisconsin	5-8.

Internal brown spot, cause undetermined, was reported from Connecticut and Washington.

Malnutrition or potash hunger was reported from Connecticut by G. P. Clinton as follows:

> "One very definite report. Had trouble last year because of no potash in fertilizer. This year fertilizer was obtained with potash and no trouble was experienced except on a piece where last year's fertilizer was used and trouble resulted as last year."

Sunscald, caused by high temperature, was observed on potatoes in light, sandy soil in Idaho by M. Shapovalov. Scalding of potatoes lying on the surface of the ground is not uncommon but scalding while still beneath the surface is less frequently found. In this particular case two fields were seen, each containing several acres, where the potatoes were planted rather shallow and had no large vines to shade the ground. The weather had been extremely hot, being above 100° in the shade for several days (107° at Boise, Aug. 15). The tubers were flabby with dark brown skin and brownish flesh throughout. Sun scald was found on potatoes arriving on the market from North Carolina (June 18-25, 6 cars averaging 33% scald), and Virginia (July 1, 17, 22, and 26, 4 cars, averaging 13%).

Spindling sprout, cause undetermined, was reported from Connecticut, Michigan, and Washington. Regarding the disease in Michigan, C. W. Waid says:

> "Spindling sprout is becoming more prevalent each season. In a few fields it was noted that fully 25% of the hills were affected. The number of fields affected with this trouble, of course, is as yet quite limited but it is one of the diseases that needs to be watched."

Lightning injury was reported from Mason County, Michigan.

Chlorosis (non-parasitic) - This disease which was reported in 1919 from Idaho, occurs especially in the southern part of that state in irrigated potato fields according to C. W. Hungerford. The average per cent infection for that district is estimated at 1%. The disease is relatively unimportant but it reduces the yield somewhat. It was also reported from Washington in 1920.

A spot (non-parasitic) was reported from Minnesota for the first time. The spots occurred chiefly on Irish Cobblers and were small, sunken and purplish, located mostly near the stem end and sometimes extended one centimeter into the flesh of the tuber. The spots did not spread in storage. An examination of these tubers in the Bureau of Plant Industry leads to the temporary opinion at least that the spots might be due to bruises from contact with small pebbles.

DISEASES OF TOMATO

Leaf spot caused by Septoria lycopersici Speg.

Septoria leaf spot was reported in 1920 from practically all of the states east of the 100th meridian, but no reports were received from any of the western states. In general the disease was the cause of less damage than last year as it was said to be less abundant in the important tomato canning states of New York, New Jersey, West Virginia, and Ohio. On the other hand in Indiana, Michigan, and Iowa it was apparently more prevalent than in 1919.

The disease was much worse in some parts of the individual states than in others. Thus, in New Jersey, it was mostly in the southern half; in Pennsylvania it was especially severe in Erie County but also bad in Adams, Lehigh, and Sullivan Counties. In Virginia it was most important in the western canning sections where defoliation was almost complete by September 1. In North Carolina it was said to be prevalent at elevations below 3000 feet and in Wisconsin it was worst in the southeastern section of the state.

The disease was most abundant in the group of states comprised of New Jersey, Delaware, Maryland, Virginia, West Virginia, North Carolina, Kentucky, and Tennessee. It was also important in Pennsylvania, Ohio, Indiana, Illinois, Michigan, Iowa, Missouri, Kansas, Oklahoma, and Arkansas, but in the Gulf states it was not serious, being very rare in Florida. In New England and westward through the northern tier of states, with the exception of Michigan, it was of minor importance.

This was mentioned as the most important tomato disease in Virginia and the same statement holds true for all states in the same group as given above. In Indiana it was the most important parasitic disease but was probably secondary to blossom-end rot. In New York it was estimated that of the total reduction in yield from all leaf diseases, one-fourth was due to Septoria.

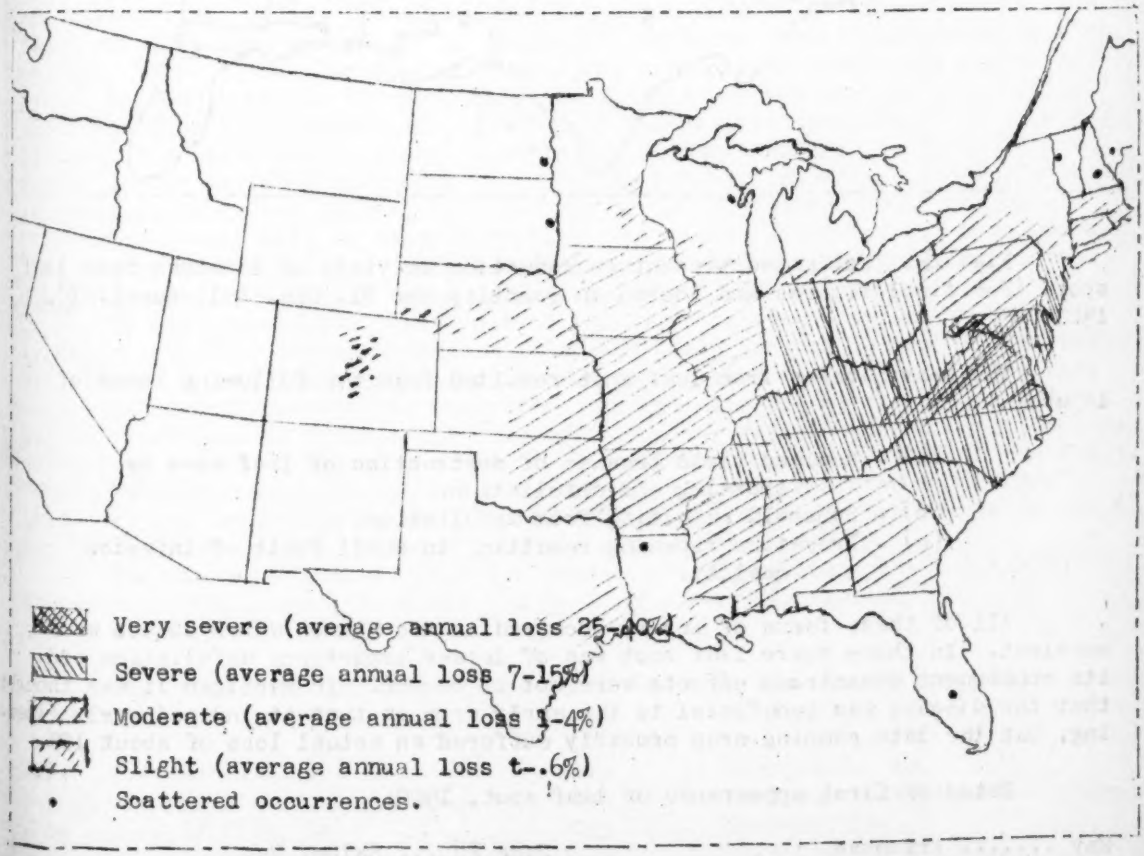
Very severe (average annual loss 25-40%)
Severe (average annual loss 7-15%)
Moderate (average annual loss 1-4%)
Slight (average annual loss t-.6%)
Scattered occurrences.

Fig. 45. Distribution and severity of Septoria leaf spot of tomato as shown by records of the Plant Disease Survey, 1920.

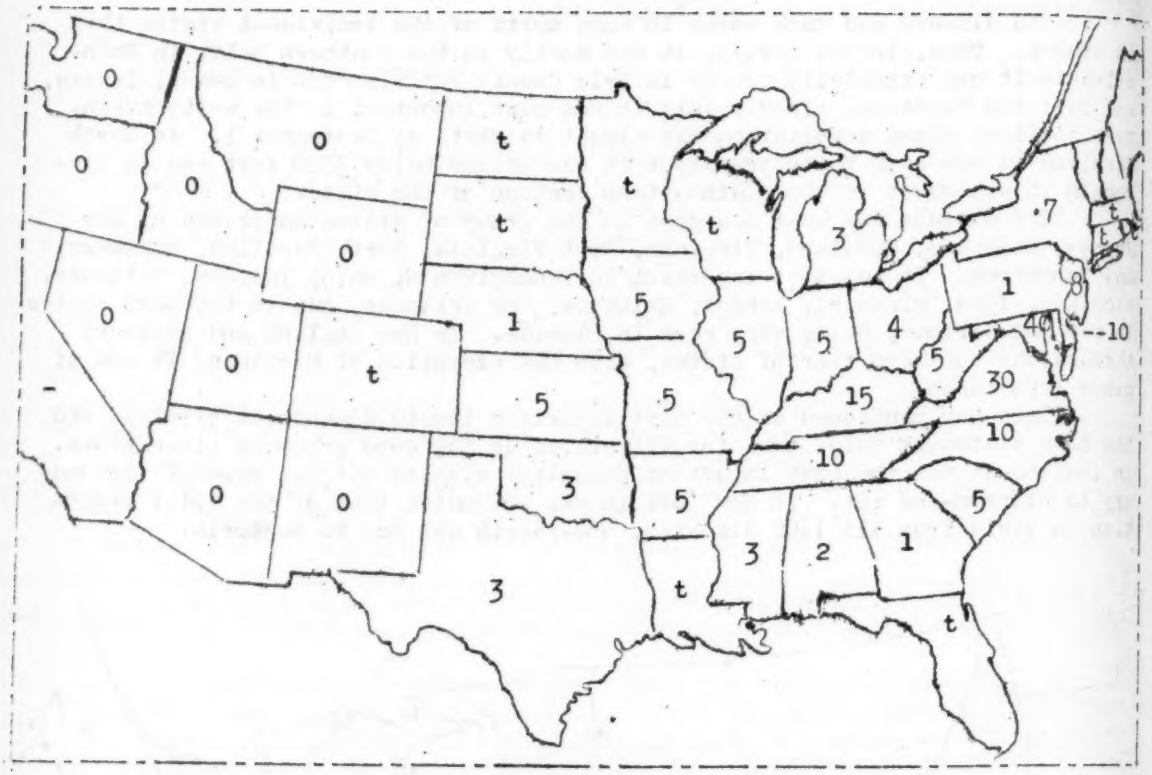

Fig. 46. Estimated percentage reduction in yield of tomatoes from leaf spot. (For final figures and losses in quantity see Pl. Dis. Bul. Suppl. 18, 1921.)

The heavy losses from leaf spot resulted from the following forms of injury:

(a) - Reduced yield because of destruction of leaf area by spotting and defoliation.
(b) - Sunscald resulting from defoliation.
(c) - Premature ripening resulting in small fruit of inferior quality.

All of these forms of injury occurred in the states where losses were heaviest. In those where leaf spot was of lesser importance defoliation and its consequent disastrous effects were not so common. In Michigan it was thought that the disease was beneficial to the early crop in that it induced early ripening, but the late canning crop probably suffered an actual loss of about 10%.

Dates of first appearance of leaf spot, 1920:

May ..... Arkansas
June 10 ... Crystal Springs, Miss.
June 11 ... Ohio
June 24 ... Indianapolis, Ind.
June 28 ... Salem, Va.
July 20 ... Hennepin County, Minn.
August 15 . Madison, Wis.
September . Amherst, Mass.

The greatest injury was reported as taking place as follows:

Kentucky ..... August and September while fruit was ripening.
Mississippi .. June 25-July 1 when fruit was 2/3 mature, or less.
Indiana ..... September, when fruit was being picked.
Wisconsin .... August 15-September 15, when plant was fully developed.

Practically nothing was reported to the Survey during 1920 concerning the success of control measures or varietal susceptibility.

Fusarium wilt caused by Fusarium lycopersici Sacc.

Fusarium wilt occurred in about the same regions as usual although reports indicate that it is spreading annually to new fields. Evidence of extensive introduction with southern plants was observed in Indiana last year. The causal Fusarium is already present in practically all parts of the southern states but in east central and more northern states it is still localized. In 1920 reports of occurrences in new localities came from New Jersey, Kentucky, and Indiana, and it was identified for the first time in two southern Michigan counties. A number of reports of geographic range in individual states were received. Thus, in New Jersey the disease was confined mostly to the southern part; in West Virginia it was local; in Kentucky it was serious principally along the Ohio River between Louisville and Paducah; in North Carolina it was all over the state but most prevalent in the Piedmont soils; in Texas it was mostly in the east; in Arkansas in the southwest particularly; and in Indiana it was serious in the central section, but not in the Orange County crop. In California it was said to be present in all parts of the state, but more prevalent in the sandy soil regions. In Georgia, Alabama, Mississippi, Louisiana, and Tennessee, it was said to be generally distributed over each state.

In prevalence, wilt was about as last year although New Jersey, Georgia, Arkansas, and Ohio indicated more. It caused heavy general losses in the southern states, taking practically all of the crop in some fields and gardens that were planted with susceptible varieties. In the Ohio Valley states heavy local losses occurred. In Indiana and Ohio much loss occurred in greenhouses, Indiana estimating a loss of 15% of the greenhouse crop as compared with 2% in the field. The percentage losses, as estimated by the Survey, are presented on the map (Fig. 47) and the losses in quantity by states, and also for the entire country, are to be given in Plant Disease Bulletin Supplement 18, 1921.

The following estimates of the percentage of affected plants in certain states have been given: Kentucky - 10%, Georgia - 90%, Louisiana - 40%, Arkansas - 5%, and Ohio - 2-25%.

The dates when the disease was first noted in 1920 in various states are as follows:

May ..... Baton Rouge, La.
May 15 .... Crystal Springs, Miss.
June ..... Griffin, Ga.
June ..... Arkansas.
June 24 ... Indianapolis, Ind.
July 1 .... Perryville, Mo.
July 23 ... Elkhorn, Walworth County, Wis.
July 24 ... Starkey, Va.
July 26 ... Erie County, N. Y.

Several collaborators commented on the use of resistant varieties as a means of evading the disease, and their notes are quoted below.

Fig. 47. Estimated percentage loss by states for Fusarium wilt of tomato, 1920.

Virginia: (Fromme) Norton and Marvel fully resistant in one planting where other varieties were almost a complete loss.

Kentucky: (Valleau) Some resistant strains are being tried in the canning sections with very promising results.

Tennessee: (Essary) Resistant varieties are being grown extensively, especially the Globe.

Georgia: (McClintock) Some commercial varieties as Globe, Duke of York, etc. are partially resistant but the only markedly resistant strains are those developed through continued selection on infested soil.

Mississippi: (Neal) Resistant varieties are not used by the large commercial growers; only the small gardeners employ them. The wilt resistant strains sent out by the Office of Cotton, Truck and Forage Crop Disease Investigations have been found effective in many instances.

Ohio: (Selby) Selections from Marvel, Arlington, and Columbia show excellent resistance.

Indiana: (Gardner) Variety Marvel, used as substitute for Bonny Best in greenhouse by one grower, gave good satisfaction.

Yellow blight probably caused by Fusarium spp.

In 1920 yellow blight was reported from Idaho, Nevada, Washington, Oregon, and California and what seems to be this disease was also reported from Arizona and New Mexico. The majority of these states and also New Mexico unite in expressing the opinion that yellow blight was less severe than in 1919. A comparison of the estimated losses for the years 1919 and 1920 also shows this.

Table 75. Losses from yellow blight of tomato in 1919 and 1920.

States	Percentage loss	
	1919	1920
Nevada	10	8
Idaho	50	25
Washington	10	8
Oregon	15	10
California	5	4

In New Mexico the damage was estimated as not exceeding 5%, and in Arizona about 10% of the crop was lost on account of a disease that resembled yellow blight. The blight was present in Idaho wherever tomatoes are grown, affecting about 35% of the plants. In Oregon it is very important in the dry, hot sections of the eastern part of the state and the Columbia River Basin. The disease was reported as first observed June 30 at Lewiston, Oregon, and July 7 at Beatty, Nye County, Nevada.

No cases of resistance in varieties were reported and no control methods were indicated.

Early blight and nail-head spot caused by Macrosporium spp.

Early blight, causing a leaf spotting with defoliation and in some cases a fruit rot, occurred in states east of the 100th meridian but was not reported from any of the states west of that line. For the most part it was about as prevalent as usual but West Virginia, where the disease is sometimes seen, reported less, and Louisiana, Texas, and Ohio reported more than in 1919.

Nail-head spot was only reported to the Survey through the medium of the market inspectors who recorded the disease on tomatoes from Florida, Mississippi, Texas, Arizona, California and Mexico. It is becoming rather apparent that nail-head spot is a disease distinct from the early blight and fruit rot that we have generally attributed to Macrosporium solani.

Most of the collaborators reporting early blight mentioned it as general in their states but in Ohio it was unusually bad throughout the northern section, where it caused the greater part of the defoliation that occurred there. In Indiana it was serious in the southern part of the state and in the gardens and

greenhouses about Indianapolis; and in Louisiana it was mentioned as being southern in its range.

Tentative estimates of percentage loss have been made and are given in Table 76. Final estimates in percentages and quantity will appear in Supplement 18, 1921.

Table 76. Percentages loss from early blight of tomato, 1920.

Per cent	States
Trace	New England, Wisconsin, Iowa.
Trace to 1%	New York, Maryland, Indiana, Illinois, Michigan.
1%	Delaware, West Virginia, Virginia, North Carolina.
2%	Tennessee, Texas.
3%	New Jersey, Alabama.
5%	Ohio, Mississippi.
10%	Florida (mostly nail-head spot)

A table showing the percentage of infection of Florida tomatoes as found on the market from February to May, 1920, has already been given (Pl. Dis. Bul. 4: 33-34. 1920). A condensed summary for all states for the year is given below.

Table 77. Losses from nail-head spot as shown by examination of cars at destination by inspectors of the Bureau of Markets, 1920.

Origin of shipment	No. cars with infected fruit	Average Percentage of infection	Origin of shipment	No. cars: with infected fruit	Average percentage of infection
Arizona	1	6	Mississippi	4	14
California	2	8	Texas	2	6
Florida	108	13	Mexico	5	7

Total number cars with nailhead spot 122
Total number cars inspected 878

Dates of first observation:

May .....Baton Rouge, Louisiana.
May 10 .....Jackson, Mississippi.
August 16 .....Green County, New York.

No varietal resistance or control measures were reported to the Survey in 1920.

Mosaic (cause undetermined).

During 1920 mosaic was reported to the Survey from twelve states: Connecticut (more, of moderate importance), New York (probably more than last year,

seems to be increasing in importance), New Jersey (abundant), Pennsylvania (about same as 1919), Louisiana (about same, very important), Arkansas (more), Ohio (only in greenhouses, less than usual), Indiana (less, very destructive locally, in general too late in appearing to do much damage), Wisconsin (one report), Iowa, Oregon (of slight importance), and California (unusual increase over 1919; affected plants did not produce any fruit).

Figures showing the extent of infection and losses were given as follows:

Table 78. Percentages of injury and loss from tomato mosaic, 1920.

State	Percentage injury	Percentage loss	Maximum percentage in any field
Pennsylvania	4	slight	10
Louisiana	-	5-10	100
Arkansas	5	-	-
Indiana	25	2	100
Wisconsin	-	trace	-
Iowa	-	9	-
Oregon	-	slight	90 greenhouse
California	-	7	-

In New York, mosaic was said to be present in nearly every patch in Albany County and from 7-65% was to be found in many fields in Erie County.

Dates of first observation by collaborators:

April ..... Baton Rouge, Louisiana.
May ..... Arkansas.
May 24 ..... Albany County, New York.
June 24 ..... Indianapolis, Indiana.
July 20 ..... New Haven, Connecticut.

No difference in the susceptibility of varieties to mosaic were reported to the Survey during 1920.

An important contribution to our knowledge of new hosts and overwintering has been made by Crawford during the past year (Crawford, R. F. Overwintering of mosaic on species of Physalis. Phytopath. 11: 47, 1921). He has transferred mosaic from the root stalks of Physalis longifolia, a common perennial solanaceous plant, to both tomato and pepper, and has also transferred infective material from tomato to the following wild plants of this family that occur in Iowa and secured infection: Solanum dulcamara, Solanum nigrum, Physalis longifolia, Nicandra physalodes, and Datura stramonium.

Late blight caused by Phytophthora infestans (Mont.) De Bary.

Phytophthora was reported on tomatoes in 1920 from New York, Pennsylvania, Ohio, West Virginia, Virginia, and North Carolina. The distribution as given by collaborators is presented in Fig. 48. In New York it was stated that it was present only where tomatoes were grown adjacent to blighted potatoes and in

Pennsylvania it was mentioned that the greater prominence of the disease on tomatoes was no doubt correlated with the epiphytotic on potatoes. In this connection it should be recalled that Giddings and Berg (A comparison of the late blights of tomato and potato. Phytopath. 9: 209-210, 1919) have found the strains of Phythphthora on the two hosts to be biologically different and that while the potato strain may attack tomato it is not nearly so virulent, nor does it produce the same symptoms, as the tomato strain. More complete information is needed concerning the geographical range of this tomato strain of the fungus and it is hoped that during 1921 collaborators who have the opportunity will make as many observations on the disease as possible. Tomato late blight is confined to the higher altitudes at least in the southern part of the infection area. Thus, in the southwestern part of Virginia, Fromme says it is restricted to the higher altitudes, and Jehle, in North Carolina, reports it in the mountain counties with elevations of 3000 feet and above.

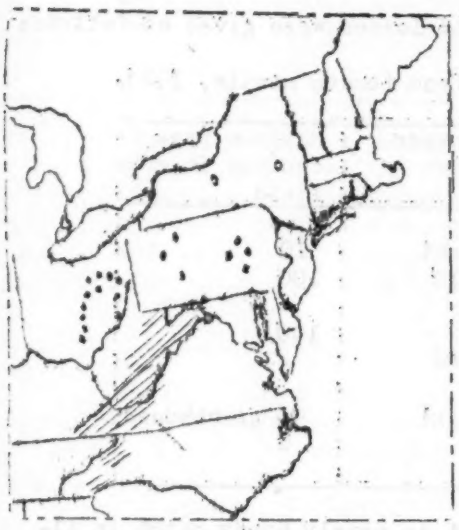

Fig. 48. Geographis distribution of late blight of tomato in 1920.

Fruit rot as well as leaf blight occurred in all states and in New York and Pennsylvania it was said to be the most important form of injury.

Regarding losses, 10 to 20% reduction in yield was reported locally in Pennsylvania. One per cent loss was estimated for the state of Virginia, 5% for West Virginia, and 2% for North Carolina. In all states except New York as high as 100% infection was reported in individual fields, 100% loss took place in some cases, and in West Virginia it is estimated that 50% of the plants in the state were infected.

More loss and wider occurrence were recorded from all states except Virginia and North Carolina. The abundance of the disease in Ohio was unusual.

Dates of first observation:

July 1 ..... Wyoming County, West Virginia.
July 12 ..... Albany, New York.
August 19 ..... Ohio.

Good control with Bordeaux was reported from West Virginia and North Carolina.

Bacterial blight caused by Bacterium solanacearum EFS.

This disease was reported from the Gulf States, North Carolina, and Arizona. Two collections were also made in Virginia (Roanoke and Chesterfield Counties) and one in West Virginia (Monongalia County). In North Carolina, Jehle reported it as very prevalent in Transylvania County and also prevalent in the Coastal Plain counties. In Mississippi and Alabama the majority of reports were received from the coast counties also. Losses for the year are estimated as follows:

Table 79. Estimated losses from bacterial blight or tomato, 1920.

State	Per cent loss	State	Per cent loss
North Carolina	5	Alabama	1
South Carolina	4	Mississippi	1
Georgia	2	Louisiana	2
Florida	5	Arkansas	1

As high as 75% infection was observed in North Carolina and 5% in Mississippi.

In Arizona, where this disease has been confused with various Fusarium troubles, it was clearly distinguished last year according to J. G. Brown. Material from Jerome showed the organism both by culture and microscopic examination. It is thought that the disease is much more prevalent than commonly supposed in that state.

Bacterial wilt was first observed in Mississippi on June 10 at Poplarville and in Virginia on July 28 in Chesterfield County.

Blossom end rot (non-parasitic)

This trouble was reported from 15 scattered states in most parts of the country. It seemed to cause less complaint than last year in the northeastern part of the United States but was a more serious factor than usual in the western Lake States and Iowa. In Indiana, Minnesota, Iowa, and Texas the average loss was estimated at 5% of the crop, and in New York and Wisconsin losses of 1% were estimated. In Indiana and Mississippi this disease was considered responsible for more loss to the grower than any other. One field in the former state yielded 8 tons of good fruit and 3 tons of rotted fruit per acre, a loss of 27%. It was estimated that the disease was present in about 90% of the Indiana fields and that 50% of the plants in those fields bore one or more affected tomatoes.

It is generally recognized that blossom end rot is caused by unfavorable soil water conditions but not all are in agreement as to just what the conditions are that bring about the disease. It is therefore of interest to note the following reports of collaborators:

New York: (R. P. White for Niagara Co.) "Only a few fields that were planted late or did not get a good start were caught by the dry spell of August and show a great deal of blossom end rot."

Georgia: (McClintock) "Very prevalent this season to date (July 15) due to the dry weather of the past month."

Texas: (Taubenhaus) "Very important because of excessive rain."

Indiana: (Gardner) "Worse on soils with gravel sub-soil."

Idaho: (Hungerford) "Common in non-irrigated sections. Also doing considerable damage in irrigated sections where water supply has not been sufficient."

Dates of first recorded appearance of blossom end rot, 1920:

May 10 ..... Crystal Springs, Miss.	July 19 ..... Ohio.
June ..... Arkansas.	August 1 ..... Ramsey County, Minn.
July 12 ..... Albany County, N. Y.	September 30 .. Vermont.

It was reported by Gardner from Indiana that the Horticultural Department there finds single plant strains that vary in susceptibility and plans to select for resistance.

Buckeye rot caused by Phytophthora terrestria Sherb.

During 1920 buckeye rot was reported in the field by Jehle from North Carolina where it was said to be quite prevalent in the Coastal Plain Counties causing an estimated loss of one or two per cent by rotting of the fruits. It was also reported from Arlington Farm, Virginia, by F. J. Pritchard as follows:

> "Buckeye rot destroyed a large part of a variety test at Arlington and was present in all tomato fields on the farm. It probably destroyed .5% of the fruit."

In Indiana it occurred in a few greenhouses causing loss of the lower fruits - first observed there June 4.

Phoma rot caused by Phoma destructiva Plowr.

The only states reporting this in the field are Iowa and California. Inspectors of the U. S. Bureau of Markets, however, found this rot in tomatoes from six of our southern states and from Canada, Cuba, and Mexico. A report of the percentages of Phoma rot, found in individual carlots from January to June 1920, has already been given (Pl. Dis. Bul. 4: 35-37, 1920). A condensed summary of the Phoma situation in the market is given in Table 80.

Table 80. Losses from Phoma rot caused by Phoma destructiva, as shown by examination of cars at destination by inspectors of the Bureau of Markets.

Origin of shipment	Percentage of decay: Number of cars	Per cent	Origin of shipment	Percentage of decay: Number of cars	Per cent
Arizona	2	2-4	Tennessee	8	2-20
California	4	25-40	Texas	5	11-20
	9	1-18	Canada	1	6
Florida	14	50-85	Cuba	7	4-37
	64	25-47	Mexico	69	1-35
	239	1-23			
Mississippi	2	45			
	38	1-23			

Total number of cars with decay..... 462
Total number of cars inspected (approximate)..... 878

In connection with this table it should be mentioned that associated with the Phoma rot there was usually also considerable decay due to other causes, principally Rhizopus and Fusarium. It was difficult for inspectors to distinguish between these various rots and to make percentage estimates of the losses caused by each.

Soil rot caused by Rhizoctonia sp.

A statement of the occurrence of soil rot in shipments of tomatoes from January to May, 1920 has been given (Pl. Dis. Bul. 4: 37-38, 1920). A note by G. K. K. Link on soil rot in Mexican tomatoes is also recorded there.

The only collaborators reporting the disease in 1920 were those in Ohio and Washington.

Stripe or winter blight (bacterial)

This disease was reported from Massachusetts, New York, New Jersey, and Pennsylvania. How this disease compares with the new bacterial disease recently reported by Gardner and Kendrick (Phytopath. 11: 55. 1921, See also new diseases in this summary) remains to be seen.

From Massachusetts the report comes that it has been serious in the greenhouse since 1912. In New York it was reported very serious in the tomato districts causing a loss of about 2%. In Niagara County, New York, it killed practically all the leaves on many plants and was much more serious than Septoria as a cause of defoliation. It did not attack the fruit in the field as it did in the greenhouse.

In New Jersey, Cook reported the "so-called winter blight" as very severe out of doors in some localities, whereas it has previously been confined mostly to greenhouses. The Department at Washington has also received several field grown specimens of the disease from New Jersey, according to F. J. Pritchard.

Thurston and Orton in Pennsylvania report less winter blight than in 1919 and state that it is chiefly a greenhouse trouble but occurs rather commonly outside though to a less serious extent. For the most part it was not severe in the state except for one greenhouse at Kennett Square that came to their attention. It was first observed outdoors in Pennsylvania, July 29 and in New York August 26 (Albany County).

Rhizopus rot caused by Rhizopus sp.

Table 81. Losses from Rhizopus rot as shown by examination of cars at destination by inspectors of the Bureau of Markets, 1920.

Origin of shipment	Number of cars with decay	Average percentage of decay	Origin of shipment	Number of cars with decay	Average percentage of decay
Arizona	1	2	Ohio	2	23
California	24	15	Tennessee	31	17
Florida	173	13	Texas	53	14
Mississippi	35	17	Cuba	7	7
Missouri	5	12	Mexico	55	9
New Jersey	1	30	Unknown	2	14
Total number of cars with decay				389	
Total number of cars inspected (approximate)....				878	

Rhizopus rot, associated with other decays, caused considerable loss to tomatoes in transit as shown by the accompanying table. It was also a disease of some importance in southern California and in the San Joaquin Valley of that state. Three per cent loss is estimated for California.

New diseases.

Bacterial spot caused by an undescribed organism has been reported by Gardner and Kendrick (Phytopath. 11: 55. 1921) from Indiana and nearby states attacking stems, leaves, and fruits. The fruit spots are extremely objectionable to gardeners and canners. No resistant varieties have been found as yet. The organism is carried over winter on the seed and seed disinfection with mercuric chloride (1-3000 for 5 minutes, and washed 10-15 minutes) has been found safe and effective.

Stem girdle caused by a new species of Phytophthora has been reported by Reddick (A fourth Phytophthora disease of tomato. Phytopath. 10: 528-534, 1920) causing damage in the vegetable greenhouses at Cornell University, Ithaca, New York. This is the only present known occurrence of the disease.

The symptoms as described by Reddick, are:

(a) - typical damping-off of seedlings;
(b) - a girdling of stems of all ages and at any point;
(c) - blight of foliage, usually in limited areas but occasionally involving one or more leaflets;
(d) - a rapid rot of the fruit;
(d) - gradual death of foliage from the base and eventual death of the plant as a result of late root infection.

Blossom blight caused by Sclerotinia sp. was reported from Albany County, New York by H. W. Fitch, July 29.

Leaf roll, very similar in appearance to potato leaf roll, was found at the United States Department of Agriculture Experimental Farms at Rosslyn, Virginia, and reported by F. J. Pritchard (See Pl. Dis. Bul. 4: 91-92, 1920 for symptoms).

Other diseases.

Leaf mold caused by Cladosporium fulvum Cke. - reported in the greenhouses in New Jersey, Pennsylvania, Ohio, Indiana, and Iowa. In the field it was thought to be more prevalent than usual in Ohio. Sulphur dust failed to control the disease in one Indiana greenhouse that was under observation.

Summer blight, cause unknown, was said to be more serious than last year in California, causing a thickening and curling of the leaves, blue veins, and final wilting. D. G. Milbrath reported a 2% loss for California and stated that in the early crop many plants were killed in the field before blossoms could set.

Anthracnose caused by Colletotrichum phomoides (Sacc.) Chester, was reported as very abundant in New Jersey and as occurring in Indiana (not a serious factor). A rot of ripe fruit especially in transit.

Damping off caused by various organisms - reported from New York, causing injury to seedlings. In one house in Orleans County 300 boxes or 300,000

plants were thrown away because of damping off.

Sclerotium blight caused by Sclerotium rolfsii Sacc. - prevalent in Texas causing .5% loss.

Bacterial soft rot of fruit was reported by Fromme as more prevalent than usual in Virginia, causing severe loss in some sections, particularly Montgomery, Roanoke, and Botetourt Counties. It caused a rot of green and ripening fruit, injuring about 10% of the crop of the state. As high as 50% fruit rot was found in an individual field. First observation - September 1 at Roanoke.

Melanconium spot caused by Melanconium sp. reported from Ross County, Ohio by Selby.

Gray mold, Botrytis sp. - reported as local in green houses of Summit and Wayne Counties, Ohio by Selby. Sanitation gives good control.

Root knot caused by Heterodera radicicola (Greef) Mill. - reported from Georgia (serious on plantings in sandy soils), Texas (fairly important, .5% loss in the sandy soils), Ohio (slight in the greenhouse) and Indiana (found on southern-grown plants and on crop from these plants. The use of southern seedlings results in importation of nematodes).

Black spot, cause undetermined, reported from Washington.

Blossom drop, non-parasitic - reported from Ohio (in greenhouse), Texas (fairly prevalent, unimportant .1% loss), and Arizona (severe locally).

Growth cracks, non-parasitic, occurred commonly but were only reported to the Survey by Hungerford from Idaho and Gardner from Indiana. In the latter state cracking of the fruit was the most important source of loss to the canning crop. It occurred on fruit on all plants and probably caused a loss of 5% to the canners of the state.

Sunscald, - reported from Ohio and Indiana. It also occurred in many other states where defoliation of plants occurred either because of Septoria or some other fungus.

DISEASES OF SWEET POTATO

Stem rot caused by Fusarium batatatis Woll. and F. hyperoxysporum Woll.

Fusarium stem rot apparently did less damage than usual in most of its range. The disease was said to be increasing in importance in Mississippi, particularly in the northwestern portion. In New Jersey it was very abundant, but control measures were said to be satisfactory.

Dates when the disease was first noticed were reported only from Mississippi (June 10 at New Albany) and Arkansas (May). For reports of losses see Plant Disease Bulletin Supplement 18, 1921.

Black rot caused by Sphaeronema fimbriatum (E.& H.) Sacc.

According to reports, received, black rot was generally prevalent, as usual, and was responsible for heavier losses than any other disease of sweet potato, especially in the southern states. Except in Mississippi, it was not reported to have been more important than it ordinarily is.

The disease was destructive on young plants in seed beds, as well as on the plants and tubers in the field, and tubers in storage and transit. Estimates of reduction in yield due to black rot were as follows:

Table 82. Estimated percentages reduction in yield from black rot of sweet potato, 1920.

State	Per cent loss	State	Per cent loss	State	Per cent loss
New Jersey	16	Mississippi	10-15	Indiana	.5
Tennessee	10	Louisiana	5	Iowa	3.
North Carolina	10	Texas	8		
Georgia	5	Arkansas	2		

Black rot also caused losses in transit, as shown in Table 83.

Dates of first appearance of the disease were reported from Mississippi (May 15, Sturgis), Louisiana (October, Bayou Sara), and Arkansas (May).

The variety Nancy Hall was said to be most susceptible in Mississippi. Growers in that state experienced some difficulty in obtaining seed free from disease, particuly black rot.

Rots caused by various organisms.

Various rots caused losses in the field, in storage, and in transit. The most important of the transit rots were black rot (Sphaeronema fimbriatum (E.& H) Sacc.), dry rot (Diaporthe batatatis (E.& H.) H.& F.), Rhizopus soft rot, and Fusarium rot, which were reported by inspectors of the Bureau of Markets as follows

Table 83. Losses to sweet potatoes in transit from various rots as reported by inspectors of the Bureau of Markets, 1920.

Origin of shipment	No. cars shipped	Approximate No. cars inspected	Amount of decay: Black rot No. cars	Black rot Per cent	Dry rot No. cars	Dry rot Per cent	Rhizopus No. cars	Rhizopus Per cent	Fusarium No. cars	Fusarium Per cent
Alabama	453	15	1	2	-	-	15	10	1	10
Arkansas	287	15	4	7	1	8	20	11	1	4
California	648	1	-	-	-	-	1	18	-	-
Delaware	1431	42	4	7	4	3	35	19	-	-
Florida	61	0	-	-	-	-	-	-	-	-
Georgia	635	45	7	11	6	6	31	8	2	9
Indiana	* --	1	1	3	-	-	1	2	-	-
Kentucky	* --	1	-	-	-	-	1	10	-	-
Louisiana	375	23	3	2	2	9	20	18	-	-
Maryland	1208	15	4	27	-	-	15	19	-	-
Mississippi	55	4	3	18	2	14	5	6	-	-
New Jersey	2573	6	1	4	-	-	6	17	-	-
New Mexico	27	0	-	-	-	-	-	-	-	-
N.Carolina	859	26	11	8	4	3	18	13	1	2
Oklahoma	*--	3	2	6	1	3	1	6	-	-
Porto Rico	*--	3	1	18	-	-	3	49	-	-
S.Carolina	*--	2	2	10	-	-	2	33	-	-
Tennessee	1175	28	11	8	1	13	27	12	1	6
Texas	480	19	9	13	7	13	19	14	-	-
Virginia	5151	57	5	27	2	36	38	13	-	-
Unknown	--	8	2	6	1	5	9	12	1	17
All other	*71	0	-	-	-	-	-	-	-	-
Total	15691	314	71		31		267		7	

Storage rots caused by various organisms - New Jersey (heavy losses), Georgia (chiefly soft rot, but some black rot, etc. general but less than usual due to increase in storage houses; bad in banked potatoes; reduction in yield 25%), Mississippi (general, more than usual, reduction 20%), Kansas (from 15-20% loss in some storage houses).

Soft rot caused by Rhizopus nigricans Ehr. - Virginia (data from market inspection on 21 shipments from eastern section show 12% loss; storage loss will equal or exceed this), Georgia, Arkansas (less than usual, much better storage; 8% loss), Iowa (20% loss), California (about as usual, very serious).

Foot rot caused by Plenodomus destruens Harter - Alabama, Kansas (small amounts in some fields), California (San Fernando Valley, in storage).

Charcoal rot caused by Sclerotium bataticola Taub. - Louisiana (first record of occurrence in the state, of little importance; first observed October 23 at Mansfield; very moist season), Texas (fairly important as storage rot, following soft rot, .5% loss).

Java black rot caused by Diplodia tubericola (E. & E.) Taub. - Louisiana (more than usual, of considerable importance all over state; reduction in yield less than 1%), Texas (traces, unimportant).

Soil rot or pox caused by Cytospora batata Elliott.

Reported from New Jersey (More, southern half of state), Texas (important as field trouble only, 1% reduction in yield), Kansas (common in some fields).

Scurf caused by Monilochaetes infuscans Hals.

Scurf was of considerable importance in some states, due to the disfiguration of the tubers rather than to reduction in yield, which was slight. It was reported from New Jersey, Mississippi, Louisiana, Arkansas, and California and was generally distributed in all states.

Other diseases.

White rust caused by Albugo ipomoeae-panduranae (Schw.) Swingle - Arkansas (more severe than usual locally; 10% injury; first report June).

Mosaic (cause unknown) - Texas (traces), Arkansas (probably general, though not abundant).

Root rot caused by Ozonium omnivorum Shear - Texas (important only in heavy, waxy soils, reduction in yield .5%).

Root knot caused by Heterodera radicicola (Greef.) Müll. - Arkansas (general, 5% injury; first report September).

DISEASES OF BEAN

Bacterial blight caused by Bacterium phaseoli EFS.

Blight was reported in 1920 from practically all states in the eastern half of the country and from Utah and Idaho. New England and New York reported less than usual, as did also Kentucky and Wisconsin. On the other hand Pennsylvania, Indiana, and Michigan reported more than last year.

Table 84. Estimated percentage reduction in yield of beans from bacterial blight, 1920. For final estimates in bushels, see Supplement 18, 1921.

State	Per cent loss	State	Per cent loss	State	Per cent loss
New York	1.5	Ohio	4	Tennessee	2
New Jersey	1	Indiana	3	Mississippi	5
Pennsylvania	7	Illinois	3	Louisiana	8
Maryland	1	Michigan	3	Texas	3
North Carolina	3	Wisconsin	1	Oklahoma	1
South Carolina	2	Minnesota	1.5	Arkansas	1
Georgia	1	Iowa	3	Arizona	8

In 1920 Michigan produced 3,575,000 bushels of dry beans, or more than any other state, and over one-third of all the dry beans raised in the country (9,075,000 bushels). The reduction of 3%, or about 106,000 bushels, because of blight made great inroads into this enormous crop. Federal and state crop reporters frequently called attention to the losses that were occurring because of blight in Michigan, and G. H. Coons of the Experiment Station at East Lansing and O. F. Burger and G. A. Meckstroth, also of the Federal Department, diredted attention to the damage being caused. For the most part the injury was due to attack of the leaves and pods, but pathologists in New York and Michigan noted attack of the stems, producing wilt and also breaking over at the nodes.

Dates of first observation of bacterial blight, 1920:

May 5..... Starkville, Miss.	June (middle) ... Perry, N. Y.
May ..... Arkansas	July 1 ..... Madison, Wis.
June 11 ..... Ohio	July 10 ..... Ramsey Co., Minn.
June 24 ..... Marion Co., Ind.	July 31 ..... Erie Co., Pa.

Gloyer, in New York, who is trying to secure bean varieties resistant to bacterial blight, reported a correlation of the amount of disease with time of planting. Kidney beans planted at various times from the latter part of May to the first of July showed no disease on the late planted, but considerable on the early planted beans. Nixon, in Pennsylvania, experienced the same thing, losing the crop from the first planting in his garden but securing a good yield from the same seed planted later.

Regarding resistant varieties, Gloyer in New York reported the White Kidney resistant, but the Wells Red Kidney, although resistant to anthracnose, is very susceptible to bacterial blight. This observation on the resistance of White Kidney is an important one as bean varieties in general do not exhibit wide differences in susceptibility to this disease. Burkholder reported the Red Kidney to be the most susceptible of the field beans in New York.

Control measures for blight are badly needed. Nothing but general sanitation methods are to be recommended at the present time. Resistant varieties would fill a great want and some practical method of securing blight-free seed is needed.

Anthracnose caused by Colletotrichum lindemuthianum (Sacc. & Magn.) Br. & Cav.

Anthracnose occurred to some extent throughout the entire eastern half of the United States. No reports were received from west of the 100th meridian. It

was generally distributed within these states, for the most part, but in Georgia it was said to be more prevalent in the coastal counties and in Mississippi it occurred mostly in the southern half.

The disease varied greatly in abundance in different states. Less than usual was reported from Vermont last year and this in spite of a cool, wet season that would appear favorable for it. Kentucky, Georgia, Mississippi, and the South generally seemed to experience smaller losses than usual. Wisconsin and Minnesota reported less than last year, the latter state escaping loss except to the early crop. Michigan and Indiana reported the absence of anthracnose.

On the other hand the important dry bean state of New York experienced an epiphytotic of anthracnose unequaled since 1915. Parts of Ohio, Pennsylvania, and New England, also apparently shared in this outbreak.

In New York the loss of dry beans from anthracnose in 1920 was greater than in 1919, but for the country as a whole, the losses were not above those of last year.

Table 85. Percentage losses (estimated) from bean anthracnose, 1920.

Percentages	States
1	Vermont, Georgia, Minnesota, Iowa, and Missouri.
2	New Jersey, South Carolina, Alabama, Louisiana, and Kentucky.
3	New Hampshire, Virginia, North Carolina, and Mississippi.
4	Tennessee.
5	Maine, Pennsylvania, West Virginia.
10	New York, Ohio.

The following regarding weather relations was reported by collaborators:

Vermont (Lutman): Unimportant this year, possibly due to the very dry weather in June and August.

New York (Burkholder): Cool, wet weather favorable.

Kentucky (Valleau): Weather favorable only in fall.

Ohio (Selby): More abundant than usual. Abundant rainfall.

Wisconsin (Vaughan): Less. Too cool.

Minnesota (Leach): Rather scarce during later July and August.

Dates of first observation of anthracnose, 1920:

May ..... Raymond, Miss.
May ..... Arkansas.
June 26 ..... Durham, N. H.
July ..... New York.
July 1 ..... Madison, Wis.
July 4 ..... Ramsey Co. Minn.
August 25 ..... State College, Pa.

Wax varieties were mentioned as most affected in Mississippi and Wells Red Kidney was reported resistant again in New York.

Rust caused by Uromyces appendiculatus (Pers.) Lev.

Rust, causing a spotting of the leaves, and sometimes the pods, was reported from Massachusetts, New York, New Jersey, Pennsylvania, Virginia, West Virginia, Tennessee, Mississippi, Louisiana, Texas, Arkansas, Ohio, Indiana, Wisconsin, Minnesota, Missouri, New Mexico, and California. For the most part it was scattered over these states, occurring on the susceptible varieties. In Indiana it was noted especially in the northern part and in New Mexico it was abundant in the southeastern portion.

It was not a factor of any great importance except in certain local instances. Apparently it did not do quite so much damage as usual. In Virginia, where losses are sometimes heavy, Fromme says that the "rains of August seem to have lessened injury as affected plants are retaining leaves longer than in dry summers."

Dates of first observation of bean rust, 1920:

July 4 ..... Isanti County, Minn.	August 26 ..... Marshall County, Ind.
July 10 ..... Meridan, Miss.	August 31 ..... State College, Pa.
August ..... Ohio.	August (last of) Perry, N. Y.

At Perry, New York the rust was found in very slight amounts on pea beans and mediums, according to W. H. Burkholder; and in California, Lady Washington, Blackeye, California Pink, Red Mexican, and French White were attacked according to D. G. Milbrath(s report,

Mosaic (cause undetermined)

Mosaic occurred in the states from which it was reported in 1919 (Pl. Dis. Bul. Suppl. 10: 229. 1920) and in addition in Iowa, Utah, and Washington. It was about as last year in most states, although in New York there was less owing to a great reduction in the acreage of susceptible varieties of the pea and medium types. The only states mentioning mosaic as important are Utah, Idaho, and Washington. The losses that occurred in New York and Pennsylvania (3%) would also indicate that it was important in those states.

Losses of 1% or more occurred as follows according to collaborators' estimates:

Table 86. Losses of 1% or more from mosaic of bean, 1920.

Percentages	States
1	Georgia, Indiana, Illinois, Minnesota, Tennessee, Louisiana.
2	Iowa, Washington.
3	New York, Pennsylvania.
5	Idaho, Oregon.

As high as 25% affected plants were found in Mississippi, 26% in wax beans at Kalamazoo, Michigan, and 33% in Oregon. In this latter state it was estimated that affected plants failed to set more than one-third of a crop. Few Oregon fields were free from the disease.

Dates of first observation of bean mosaic, 1920:

May 15	Griffin, Ga.	July 1	Ramsey County, Minn.
June	Crystal Springs, Miss.	July 16	Freeland, Pa.
June	Arkansas.	July 30	Madison, Wis.
June 15	Humboldt, Tenn.	August 15	Vermont.
June 24	Marion County, Ind.	September 29 ...	Hadden Neck, Conn.
July	New York.		

Mosaic was reported on the following beans in 1920:

Common beans
- Field varieties
  - Pole Horticultural ..... Vermont.
  - Pea and medium types ..... New York.
- Snap varieties ..... Vermont, Connecticut, Georgia, Virginia.
- Wax types ..... Michigan, Mississippi.

Lima beans..... Georgia.

Root rot caused by Fusarium martii phaseoli Burkholder.

Root rot was reported by Burkholder as causing less injury in New York than last year. Due to sufficient moisture at podding time the yield was not reduced as much as usual. An estimate of 1 to 2% loss was made for the state. The rot appeared in the middle of June in Wyoming County, and was most destructive during August when plants were forming pods.

A disease closely resembling this was reported by Gardner from Indiana, killing plants in scattered localities. Meckstroth in Michigan also found a root and stem rot in sandy soils near Saginaw that answered the description of the New York disease.

Watery soft rot or drop caused by Sclerotinia libertiana Fckl.

This rot was reported occurring on beans in the field in New Hampshire, New York (more, 75% in one field as a stem and pod rot), Pennsylvania (serious in one to two localities in Center County), and West Virginia (more than usual but of slight importance as damage was local).

It was found in shipments of green beans from the South as follows, in Table 87:

Table 87. Losses from watery soft rot caused by Sclerotinia libertiana, as shown by examination of cars at destination by inspectors of the Bureau of Markets:

Origin of shipment	Number of cars with decay	Average percentage of decay	Origin of shipment	Number of cars with decay	Average percentage of decay
Alabama	1	2	Mississippi	3	4
Florida	3	14	South Carolina	1	8
Louisiana	5	27	Virginia	2	35
Maryland	2	9	Total	17	
		Total number of cars inspected.....		45	

Other diseases.

Powdery mildew (Erysiphe polygoni DC.) - reported from Connecticut (new to state but not a serious trouble), Illinois (in greenhouse at Urbana), and Texas (unimportant).

Leaf spot caused by Cercospora canescens was reported by Taubenhaus as important in Texas, causing a loss of 1% to fall beans. More than 1919.

Angular leaf spot caused by Isariopsis griseola Sacc. was found by J. L. Sheldon on pole bean leaves and pods in small amounts in a garden near Morgantown, West Virginia.

Root rots caused by Fusaria were reported from Massachusetts (worse), Georgia (same), Mississippi, and Missouri.

Root rot caused by Rhizoctonia sp. - reported from New Jersey (very common), Texas (unimportant), Ohio, Idaho (common in Twin Falls County), Washington, Oregon, and California.

Southern blight caused by Sclerotium rolfsii Sacc. - reported from West Virginia, (new), Georgia, Mississippi (trace observed, first noticed June 10 at Agricultural College), and Texas (unimportant).

Texas root rot caused by Ozonium omnivorum Shear was important on late beans in Texas causing about 10% loss.

Root knot caused by Heterodera radicicola (Greef.) Müll. - reported from Arkansas (general, 10% injury).

Chlorosis said to be caused by the soil being too rich in lime was reported from Texas.

DISEASES OF LIMA BEAN

Downy mildew caused by Phytophthora phaseoli Thax.

Downy mildew was more widespread and more destructive than usual in the Northeast. It occurred in Connecticut, New York, New Jersey, Pennsylvania, Virginia, West Virginia, and Ohio. In New Jersey it was said to be very destructive and in Pennsylvania it was serious in the southeastern corner of the state, causing 100% infection in some plots. At Blacksburg, Virginia practically 100% infection on young pods was noted in some gardens.

The disease was noted in New York, on Long Island, in August; in Pennsylvania at about the middle of the same month; and in Virginia at Blacksburg, August 10. Undoubtedly the disease was favored by the cool wet weather that prevailed in most of the northeastern states during August. The average rainfall for August in the states reporting downy mildew was nearly one inch in excess of the normal. Fromme, in Virginia, made observations at Blacksburg indicating restriction to higher altitudes.

Other diseases.

Bacterial spot has recently been studied and described by W. B. Tisdale and Maude M. Williamson (Abstract in Phytopath. 11: 52, 1921). They report it from Madison, Wisconsin where it was quite destructive in 1917.

Bacterial blights were also reported from West Virginia and Missouri in 1920, but the identity of these troubles is somewhat uncertain.

Leaf and pod spot caused by Diaporthe phaseolorum (C. & E.) Sacc. (Phoma

subcircinata E. & E. and Phyllosticta phaseolina Sacc.) - reported from New York (one report from Mattituck, L. I., August 10), New Jersey (abundant in southern part of state), Indiana (widespread and very destructive in some gardens), and Michigan.

Leaf spot caused by Cercospora cruenta Sacc. - reported from Long Island, New York and Boone County, Missouri.

Mosaic (cause undetermined) was observed by McClintock in Georgia and Sheldon in West Virginia, The latter reported a garden at Morgantown with scarcely a plant that was free from the disease.

Root-rot (cause undetermined) - reported from Morgantown, West Virginia. Many of the plants failed to come up and others died later in the season. A parallel row of peas also had root rot. Lima beans had been grown on the same soil the year before.

Powdery mildew caused by Erysiphe polygoni DC. caused 2-5% loss to limas along the coast in California according to D. G. Milbrath.

DISEASES OF ONION

Smut caused by Urocystis cepulae Frost.

During 1920 smut was reported from certain onion sections in Massachusetts, New York, Pennsylvania, Kentucky, Ohio, Indiana, Wisconsin, and Oregon. In Massachusetts it was largely in the Connecticut Valley, although some was found in the eastern part of the state. In New York the geographical distribution was outlined by Chupp as follows:

> "Nearly all of the onions of the state are grown in the following sections: Orange County, Wayne County, South Lima in Livingston County, Elba in Genesee County, Fulton in Oswego, and a few about Buffalo. In all of these sections, excepting Elba, where the muck has been recently put under cultivation, the smut is very serious."

In Pennsylvania it was said to be important in the Luzerne and Erie County sections. In Kentucky it was serious about Louisville. In Indiana it was found to occur only in a few fields of onions grown for sets in one section of Lake County. In Wisconsin the disease appears to be localized in the southeastern part of the state, Racine, and Kenosha Counties, and in Oregon it was confined to the northern part of the Willamette Valley.

The losses were very heavy, at least to some growers, in most of the sections mentioned above. An average state loss of 2% is estimated for Massachusetts, 20% for New York, and 5% for Wisconsin. Regarding the New York losses, Chupp writes as follows:

> "It is not uncommon either in Orange or Wayne Counties to find as high as 60% of the plants smutted. We do not grow onions in New York by the planting of sets. The seeds are put directly in the ground, using twice as much seed as is necessary in order to make up for the loss that is sure to result from the attack of Urocystis. The seedlings that do come up are quite often so badly smutted that, even though they grow to be mature onions, they have to be discarded as culls in the fall. Furthermore, in nearly all of the demonstrations that were conducted in 1920, the yield when formaldehyde was used was increased from one-third to one-half. Taking all these things into

consideration, it seems to Dr. H. W. Dye and myself that 20% reduction in yield is very conservative."

In Wisconsin it was estimated that the disease was present in about half of the commercial onion fields of the state, affecting an average of 5% of the plants and causing about that much loss.

Reports from New York and Wisconsin indicate that the disease is slowly spreading to new areas.

First observed in spring - April 19, Albany County, New York; May 5, Racine, Wisconsin.

Fig. 49. Geographical distribution of onion smut as reported to the Plant Disease Survey since 1903. Each dot represents a single county. A single report has been received also from Alabama, but there is some doubt as to its authenticity.

An important contribution to our knowledge of relation of environment to onion smut has been made by J. C. Walker and L. R. Jones during the past year (Abstract in Phytopath. 11: 52, 1921). They have found that infection occurs at temperatures from 10°-25° C., marked reduction takes place at 27.5° C. and complete inhibition exists at 29° C. Also they have shown that when successive out-door plantings are made in inoculated soil, so timed as to expose the crops of seedlings to gradually increasing temperatures, the percentage of infection falls as the soil temperatures rise. The significance of this temperature relation to the geographical distribution of the smut is pointed out.

Formaldehyde soil treatment resulted in 240% increase in yield in Luzerne County, Pennsylvania last year and 100% increase in parts of New York. The method gave satisfactory results also in Massachusetts, Indiana, and Wisconsin.

Downy mildew caused by Peronospora schleideni Ung.

States reporting this disease were New York, Pennsylvania, Mississippi, Louisiana, Oregon, and California.

According to H. W. Dye in New York there was much more downy mildew than usual, occurring wherever onions were grown, and causing a loss of 3-5% for the state. It appeared late and so did not do great damage except on some late planted fields.

Very serious losses were reported by R. C. Thomas from Ohio where some fields located on low, muck soil suffered heavily.

In Santa Clara County, California, Milbrath found the yield cut 30% in some fields of onions grown for seed.

Neck rot caused by Botrytis sp.

Neck rot was reported by collaborators from New York, Pennsylvania, West Virginia, Ohio, Illinois, Wisconsin, Idaho, Washington, and California.

J. C. Walker reported very little in Wisconsin or in the Chicago district. One lot from Lansing, Illinois, showed about 5% infection. It was common on white bulbs in the Chicago retail markets in October, according to Walker.

Table 88. Losses from neck rot caused by Botrytis sp., as shown by examination of cars at destination by inspectors of the Bureau of Markets.

Origin of shipment	Number of cars with decay	Average percentage of decay	Origin of shipment	Number of cars with decay	Average percentage of decay
California	11	8	Ohio	29	7
Colorado	2	17	Oregon	2	7
Indiana	2	9	Texas	13	7
Iowa	4	3	Washington	2	3
Kentucky	4	5	Wisconsin	1	2
Massachusetts	1	9	Spain	20	21
Michigan	2	27	Unknown	2	14
New York	5	5			

Total number of cars with decay 100
Total number of cars inspected 1314

Pink root caused by Fusarium mallii Taub.

According to Taubenhaus this disease was very important as usual along the Rio Grande Valley. It was about as prevalent as usual and caused a loss in the state estimated at 3%. A pink root disease caused by Fusarium was also reported from New York, Indiana, and California.

New York: (H. W. Dye) "Present in 25% of fields and probably reducing the yield in a few. The dry season has apparently favored the disease."

(Chas. Chupp) "First observation July 12 at Williamson. Mr. Newhall found it in 12 out of 15 fields in Wayne County where it was

equally bad on red and yellow onions."

Indiana: (M. W. Gardner) "Found in Lake County but not doing any damage."

California: (D. G. Milbrath) Pink root - Fusarium mallii - found on several islands in Delta region. Infested spots reduced 50%."

Other diseases.

Leaf spot caused by Macrosporium sp. was very severe on seed onions in the Bayou La Fourche district of Louisiana, according to Edgerton. A mold (Macrosporium) was reported as unimportant in New York.

Bulb rot caused by Macrosporium sp. was noted by J. C. Walker in the Wisconsin-Illinois section in 1917 and 1918, and recently reported by him (Phytopath. 11: 53, 1921). It did slight damage in 1920 to white sets from Somers, Wisconsin and to large white bulbs in the Chicago market.

Smudge caused by Vermicularia circinans Berk. - prevalent on white onions in Wisconsin and Chicago districts and in the Indianapolis market gardens. Damage only slight.

Fusarium rot - occasional but not serious on sets in Chicago section. In one field at Racine, Wisconsin, it was doing considerable damage to large bulbs. It was also reported from the state of Washington and by market inspectors on onions from Iowa and Texas.

Damping-off of seedlings caused by Pythium and Fusarium was serious in a few fields in Massachusetts.

Root knot caused by Heterodera radicicila (Greef.) Müll. was found near Goshen, Indiana.

Rust (Puccinia asparagi DC.) was found near Madison, Wisconsin by J. C. Walker and reported by him as follows:

"Aecial stage on seed stems and leaves of top onion (Allium cepa bulbellifera) was found in two patches in a market garden near Madison, Wisconsin. Diagnosed by Dr. Arthur as Puccinia asparagi affecting onion. This was supported by the fact that an asparagus patch intervened between two onion patches. No aecia found on asparagus but crop was cut short in early part of season. Uredo and telial stage later developed on asparagus but not on onion. A species of Botrytis attacked the onions through rust lesions so that eventually each rust lesion was invaded many times before they were mature. Botrytis lesions enlarged and eventually girdled the stems. Rust itself not serious but Botrytis caused considerable damage."

Stem and leaf rot caused by Botrytis attacking through rust lesions - See note on rust above.

Scale rot caused by a Botrytis sp. of the small sclerotial type reported by Walker as very prevalent on white bulbs in the Chicago markets during October and also noted at Madison, Wisconsin.

Dodder (Cuscuta spp.) was noted during July, 1919 by J. C. Walker on large bulb tops at Stockton, California; in 1920 by J. Monteith, Jr. on large bulb tops at Racine, Wisconsin; and September, 1920 by Walker on white sets at Lansing, Illinois, where it was doing considerable damage (See Abstract in Phytopath. 11: 53, 1921).

Rhizopus rot caused by Rhizopus sp. was found in California onions, mostly yellow Bermudas arriving in eastern markets during June.

Slimy soft rot caused by bacteria of the Bacillus carotovorus group was One of the most important decays of onions in transit. It was found in onions from many states and affected especially those shipped during the summer.

Black mold rot caused by Aspergillus niger Van Tieghem, sometimes called Sterigmatocystis niger Van Tieghem, caused 15% severe infection of bulbs in the Delta Region of California, and 2% severe infection in the Coachella Valley, according to D. G. Milbrath. In Texas, Taubenhaus reported its occurrence mostly in the Rio Grande Valley in places where onions were dug during rainfall.

In onion shipments it was reported affecting a considerable portion of the onions in 86 cars from California, 28 from Texas, 5 from Kentucky, 2 from Indiana, and 1 from each of Iowa, Michigan, Minnesota, and New York.

Blue mold rot caused by Penicillium sp. was reported by market inspectors as follows: California onions, 24 cars with 29% decay; Indiana onions, one car with 6%; Michigan onions, 4 cars with 3%; Ohio onions, one car with 3%; Texas onions, one car with 4%.

Gray mold rot caused by Botrytis sp. - reported by market inspectors as follows:

Table 89. Losses from gray mold rot of onion caused by Botrytis sp., as shown by examination of cars at destination by inspectors of the Bureau of Markets.

Origin of shipment	Number of cars with decay	Average percentage of decay	Remarks as to seriousness of decay.
California	32	9	
Illinois	1	100	Followed by slimy soft rot.
Indiana	2	2	
Michigan	2	4	
Minnesota	1	2	Associated with slimy soft rot.
Ohio	5	5	
Texas	48	20	Considerable slimy soft rot.
Washington	5	20	
Wisconsin	3	2	Advanced stage of decay.
Egypt	1	13	
Spain	17	15	Associated with other decays.
Unknown	4	28	
Total	122	Total number of cars inspected	1314

DISEASES OF CRUCIFERS

CABBAGE AND CAULIFLOWER

Club root caused by Plasmodiophora brassicae Wor.

The geographical distribution of club root on cabbage as reported to the Survey for 1920 is shown in Figure 50. On cauliflower it was reported also from

New York and Ohio. It will be noted that the disease occurred chiefly in the more northern and cooler sections of the country. An examination of past data on the range of club root shows the same sort of limitation, although it is true that a few scattering and local reports have come from some of the more southern states. Although club root is sensitive to soil reaction, it is thought that temperature may have much to do with the tendency toward restriction of the disease to northern states. Chupp (Studies on club root of cruciferous plants, N. Y. Sta. Agr. Exp. Sta. (Cornell) Bul. 387: 424-426. 1917) pointed out that infection of seedlings in agar tubes takes place at temperatures of from 16°- 21° C. (61°- 70°F.) which are comparatively cool.

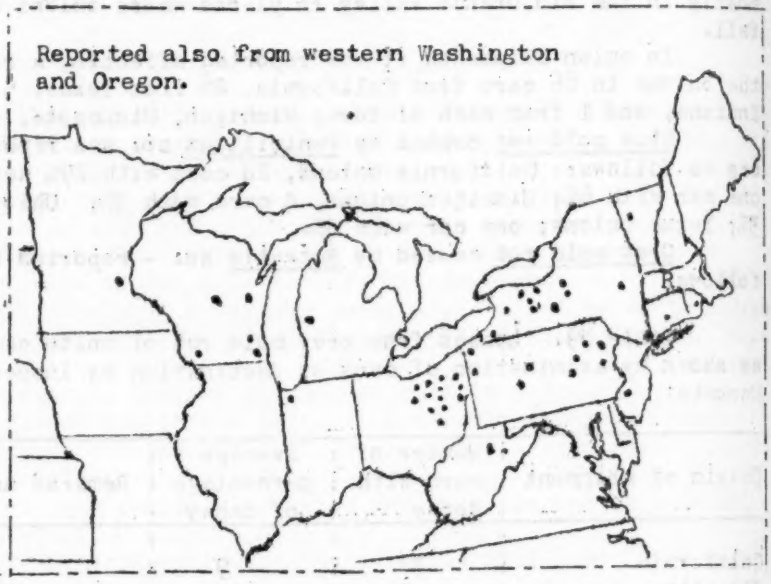

Fig. 50. Range of club root on cabbage as reported by collaborators for 1920. Each dot represents a single county where the disease occurred.

As a rule club root was most serious in gardens, especially in those small long established vegetable growing communities where cabbage or cauliflower are favored. The large commercial cabbage sections do not seem to suffer much loss from club root, and those in the west are less affected than those in the east. In the Cortland Valley district of New York, however, considerable trouble is experienced. The reductions in yield estimated by collaborators in 1920 were: Vermont 2-5%, New York 1-2%, Pennsylvania 2-5%, Wisconsin trace, Minnesota trace. The highest percentage of diseased plants found in any one field was: New York 60%, Pennsylvania 50%, Wisconsin 5%, and Minnesota 50%.

Nothing on the susceptibility of varieties nor on control was reported.

Yellows caused by Fusarium conglutinans Woll.

A good account of the geographical distribution of cabbage yellows in the United States and reasons for limitations in range has been given recently by Jones, Walker, and Tisdale (Wis. Agr. Exp. Sta. Res. Bul. 48. 1920).

In 1920 yellows was reported from the following states in the eastern half of the country: New Jersey, Pennsylvania, Delaware, Maryland, Virginia, Kentucky, Tennessee, Alabama, Mississippi, Louisiana, Texas, Oklahoma, Arkansas, Ohio, Indiana, Illinois, Michigan, Wisconsin, Minnesota, Iowa, Missouri, and Kansas. Along the northern border of the area, that is, southern Wisconsin and Michigan and northern Indiana, the disease was less severe than usual owing to the cool summer.

This undoubtedly is the most important cabbage disease, as many states mention it as their worst trouble, and it occurs widely in the commercial cabbage

sections of the east. Losses expressed in percent reduction in yield by states were estimated as follows for 1920: Virginia 16%, Louisiana 5%, Texas 4%, Indiana 5%, Wisconsin trace, and Iowa 20%. The loss in Wisconsin is small because of the cool season and because the disease is limited to the southern portion of the state and in that section the resistant Wisconsin Hollander is generally used on infested land. In Iowa, on the other hand, weather conditions were more favorable and resistant varieties are not so widely grown.

The highest percentage of disease in any one field was reported as follows: Pennsylvania 10, Virginia 80%, Tennessee 10%, and Missouri 60-100%.

In the southwest cabbage section of Virginia, Wythe and Smyth Counties, where about 5000 acres of cabbage are grown, yellows was the worst disease according to L. L. Harter and F. D. Fromme. As high as 80% was found in one field and from the district about Louisville, Kentucky, Valleau reported 30-75% loss in some of the early cabbage fields.

Dates of first appearance of yellows, 1920:

March ..... Lockport, New York.	June 24 ..... Delaware.
June 4 ..... Marion County, Indiana.	July ..... Arkansas.
June 20 ..... Amboy, Illinois.	July 15 ..... Racine, Wisconsin.
June 23 ..... Marion, Virginia.	July 27 ..... Plain View, Minnesota.

Four collaborators have furnished notes on resistant varieties:

Pennsylvania: (Thurston and Orton) Wisconsin Hollander resistant.

Virginia: (Fromme) Copenhagen Market seems especially susceptible in the southwest cabbage section. All Head Early is more so than Succession.

Michigan: (Coons) This disease is known from Wayne, Kent, Monroe, and Branch Counties. It is becoming a serious problem in Branch. The Wisconsin No. 8 is too late for this county, since they wish to ship before November and have better success with Copenhagen.

Wisconsin: (Vaughan) Use of Wisconsin Hollander general on infested soil. hence loss is small. Good results with a new strain of resistant All-Seasons developed in Wisconsin. In one test field at Union Grove, six or seven strains of Wisconsin All-Seasons were free from Yellows, while the check row gave 67% yellows.

Black rot caused by Bacterium campestre (Pam.) EFS.

More black rot than usual was reported from Vermont, Indiana, Wisconsin, and Minnesota. On the other hand, New York, Pennsylvania, and Iowa apparently experienced less than normal.

On the whole, the disease was not a very important one, although Outagamie, Dane, and Brown Counties, Wisconsin, where fields were to be found showing from 95-100% infection, suffered heavily. Imported Hollander seed in Wisconsin seemed to show most of the disease, the domestic grown seed being practically free. An estimated reduction in yield of 10% has been made for that state, while 2-5% loss probably occurred in Minnesota.

According to reports from Alabama and Mississippi, the disease was also rather serious on early cabbage in parts of those states as from 5-25% affected

plants were found in several fields in Mobile County, Alabama, and in one field near Crystal Springs, Mississippi, 10% infection was observed. In Pennsylvania about 5% loss from black rot was estimated.

Black rot was found by market inspectors in cars of cabbage from Florida, Alabama, Texas, Wisconsin, Minnesota, and New York. Some cars showed as high as 75% infection. In many cases slimy soft rot was associated with the black rot.

The disease was reported on cauliflower only from Ohio.

Dates of first observation of black rot, 1920.

May ..... Mississippi.
May 24 ..... Mattituck, New York.
June 19 ..... Ohio.
August 12 ..... Marion, Virginia.
August 15 ..... Appleton, Wisconsin.

Lutman in Vermont attributes the excess of black rot to the wet September.

Seed treatment with mercuric chloride gave good results in Wisconsin last year.

Black leg caused by Phoma lingam (Tode.) Desmaz.

In 1920 black leg was reported from New York, New Jersey, Pennsylvania, Maryland, Virginia, Georgia, Alabama, Mississippi, Louisiana, Arkansas, Ohio, Indiana, Wisconsin, and Missouri. In New York it was important on Long Island but not in the other portions of the state. I. H. Vogel reporting for Long Island made the following statement:

"In six seed fields there was a loss of 15-25% of seed and the quality was poor. In cabbage fields as many as 75% were affected and at least 80% of the fields showed infection. Loss on the Island, 5-10%."

In New Jersey, Cook reported it most abundant in Camden County where it was very destructive and in Pennsylvania it was reported only from Philadelphia County in the southeastern part of the state.

Table 90. Estimates of losses to cabbage from Phoma as given by collaborators, 1920.

State	Percent reduction in yield	Maximum percent found
Long Island, N. Y.	5-10	80
Pennsylvania	-	30
Virginia	1.5	10
Louisiana	slight	
Wisconsin	10	50
Missouri	-	24

L. L. Harter, who visited the cabbage district of southwestern Virginia near Marion and Rural Retreat on July 26 and 27, found black leg common and second to yellows in importance, but in no field did it exceed 10% infection.

In Georgia it was noted by McClintock as serious on collards grown for seed. Seventy-five percent of the plants were killed during the season due to Phoma attacks on the stem.

It will be noted that in Wisconsin this disease was far more serious than yellows as it caused 10% loss as compared with a trace from yellows.

It was stated that in Wisconsin wet weather early gave a favorable opportunity for repeated infection.

Dates of first observation of black leg, 1920:

March .....Baton Rouge, La.	June 23 .....Marion, Va.
May 15.....Racine, Wis.	July .....Arkansas.
June 15 .....Manchester Road, Mo.	July 12 .....Mattituck, L. I., N. Y.

Late varieties were more affected than early ones in Maryland. No resistance was reported from any state.

Seed treatment with mercuric bichloride gave good results on Long Island and was fairly successful in Wisconsin. The seed source is mentioned as being very important and in the southwestern Virginia section where the seed is sown directly in the field, it is thought that the elimination of the seed bed by this manner of planting is helpful.

Black leaf spot caused by Alternaria brassicae (Berk.) Sacc.

Black mold or black leaf spot caused considerable damage in San Francisco and San Mateo Counties in California, according to D. G. Milbrath. In other states it was said to be of little importance in the field. It was rather common on cabbage in transit, however. The following table shows the infections reported by inspectors of the Bureau of Markets in shipments from various states.

Table 91. Losses from black leaf spot of cabbage caused by Alternaria brassicae as shown by examination of cars at destination by food-products inspectors of the Bureau of Markets, 1920.

Origin of shipment	No. of cars with decay	Average percentage of decay	Range of percentage of decay: No. cars	Range of percentage of decay: Percent	Origin of shipment	No. of cars with decay	Average percentage of decay	Range of percentage of decay: No. cars	Range of percentage of decay: Percent
Ala.	5	48	2	100	La.	3	75	3	45-100
			3	4-22	N. Y.	14	28	3	50-90
Calif.	4	26	4	15-42				11	6-30
Fla.	42	41	8	75-100	Tex.	106	31	25	50-100
			9	35-65				81	2-45
			25	2-30	Unknown	3	22	3	7-42
Ind.	1	17	1	17	Va.	1	40	1	40

Total number of cars with Alternaria 179
Total number of cars of cabbage inspected 1252

Gray mold rot caused by Botrytis sp.

Gray mold rot was reported from California as a serious field disease in all trucking sections except the Coachella and Imperial Valleys. The cool weather and heavy fogs prevailing during the winter and spring months are especially favorable to the development of the Botrytis, according to G. K. K. Link. Gray mold rot was not reported from other states as occurring in the field, but it was observed by markets inspectors in shipments from several, as shown in the following table:

Table 92. Losses from gray mold rot of cabbage caused by Botrytis sp., as shown by examination of cars at destination by inspectors of the Bureau of Markets.

Origin of shipment	Number of cars with decay	Average percentage of decay	Remarks as to seriousness of decay.
California	2	8	In 3-6 outer leaves.
Colorado	1	62	Associated with slimy soft rot.
Florida	3	33	" " " " "
Illinois	2	33	
Indiana	1	6	In 4-8 outer leaves.
Kentucky	2	60	Generally early stage in 2-4 leaves.
Louisiana	1	100	Associated with slimy soft rot.
Michigan	6	20	In 4-6 outer leaves.
New York	19	36	Considerable slimy soft rot.
Texas	7	31	
Wisconsin	6	44	In 3-5 outer leaves.
Unknown origin	4	68	Considerable slimy soft rot.
Total	54	Total number of cars inspected	1252

Other diseases.

Downy mildew caused by Peronospora parasitica (Pers.) De Bary was unimportant in New York, Louisiana, and Texas.

Ring-spot caused by Mycosphaerella brassicicola (Duby) Lindau was reported from California, where it is of considerable economic importance throughout the year in the San Francisco Bay region on both cabbage and cauliflower, according to D. G. Milbrath.

Black leaf speck, cause unknown, was said by G. K. K. Link to be prevalent in all sections of California where the variety Winningstadt was grown.

Slimy soft rot caused by Bacillus carotovorus Jones was again reported as rather important in the field in Vermont, Pennsylvania, and Louisiana. The losses caused were estimated at 1-3% in Vermont, 2% in Pennsylvania, and 5% in Louisiana. In other states it was apparently insignificant as a field disease. It occurred very generally in shipments of cabbage, however.

Drop caused by Sclerotinia libertiana Fckl. was reported from New York, Tennessee, Louisiana, Texas, Missouri, and California. It was apparently of no particular consequence except in New York, where it was especially bad in late harvested fields, and in California. Watery soft rot caused by this fungus was prevalent on cabbage in transit, particularly in shipments from New York and Florida.

Southern wilt caused by Sclerotium rolfsii Sacc. was reported from Texas, where it was unimportant.

Stem rot caused by Corticium vagum solani Burt was reported from Washington.

Damping-off of cabbage, thought to be due to Pythium sp., and of cauliflower, caused by various fungi, was reported from New York.

Root knot caused by Heterodera radicicola (Greef.) Müll. occurred in light soils in Texas.

Malnutrition was of considerable importance in California, according to G. K. K. Link, especially where the variety Winningstadt was grown.

BRUSSELS SPROUTS

Ring spot caused by Mycosphaerella brassicicola (Duby) Lindau - California (present in 75% of the fields in San Mateo and San Francisco Counties).
Black leaf spot caused by Alternaria brassicae (Berk.) Sacc. - California.

COLLARDS

Black leg caused by Phoma lingam (Tode.) Desmaz. - Georgia (more than usual, serious on seed plants, 85% affected plants and large loss in state. All varieties attacked). - See cabbage.

HORSE RADISH

Root rot caused by Thielavia basicola (B. & Br.) Zopf. - New Jersey (common but not serious in one locality, Passaic County).
Bacterial root rot (bacteria) - Passaic County, New Jersey.

KALE

Yellows caused by Fusarium conglutinans Woll. - Indiana (severe in market gardens near Indianapolis, stunting and killing plants, first noticed June 24.)

KOHL RABI

Club root caused by Plasmodiophora brassicae Wor. - Ohio.

RADISH

White rust caused by Albugo candida (Pers.) Ktz. - Olmsted County, Minnesota.
Downy mildew caused by Peronospora parasitica (Pers.) De Bary - Indiana

(foliage spotting and distortion of floral parts in Indianapolis market gardens.)

Black root caused by Rheosporangium aphanidermatus Edson - Indiana (important in certain market sections).

Rhizoctonia sp. - Ohio (in greenhouse) and Washington.

RUTABAGA

Black leg caused by Phoma lingam (Tode.) Desmaz. - Georgia (rutabagas planted on land where collards were seriously affected last spring showed some infection in the fall).

Club root caused by Plasmodiophora brassicae Wor. - North Dakota (in new land, evidence of introduction with seed).

TURNIP

Club root caused by Plasmodiophora brassicae Wor. - Connecticut.

Black rot caused by Bacterium campestre (Pam.) EFS - Connecticut (August 31, Middlebury).

Downy mildew caused by Peronospora parasitica (Pers.) De Bary - Texas.

White rust caused by Albugo candida (Pers.) Ktz. - Texas.

Rhizoctonia sp. - Ohio (new collection).

DISEASES OF CUCURBITS

CANTALOUPE

Leaf blight caused by Alternaria brassicae nigrescens Pegl.

Leaf blight was reported only from New York, Texas, and Indiana in 1920. In Texas it occurred too late in the season to do any particular damage, but in the other states it caused considerable injury. In Indiana, where the reduction in yield due to leaf blight was estimated at 1%, it was said to be next to bacterial wilt in importance, though it was severe only in the southern part of the state. It was not destructive in clean soil, but where rotation was not practiced, as was the case in most fields, it was serious.

Bacterial wilt caused by Bacillus tracheiphilus EFS.

Bacterial wilt was generally reported as more prevalent and more severe during 1920 than usual. In Virginia and Indiana it was said to be the most serious disease of cantaloupe (Pl. Dis. Bul. 4: 96). In the latter state, where favorable weather conditions prolonged the attack of the fungus, the reduction

in yield was estimated at 3%. The disease was also reported from New Jersey, Pennsylvania, Ohio, and Mississippi. In the last named state it caused slight damage.

Dates when bacterial wilt was first observed were as follows:

July 2 ..... Vincennes, Indiana.
July 3 ..... Ohio.
July 23 ..... Chesterfield County, Virginia.

Anthracnose caused by Colletotrichum lagenarium (Pass.) Ell. & Hals.

Except in southern Georgia, where it was said to have caused a loss of 15%, anthracnose apparently was only locally important during 1920. In West Virginia it was reported to have been locally destructive in the Ohio Valley. Other states in which it was said to occur are New Jersey, Tennessee, Georgia, Alabama, Mississippi, Texas, Ohio, and Arizona.

Mosaic (cause undetermined)

Mosaic was reported as an important disease only from the vicinity of Louisville, Kentucky and from the Vincennes region in Indiana. In Kentucky it was said that 20% of the plants of the variety Rocky Ford were badly stunted on May 29, when the disease was first reported.

Other states reporting mosaic were Pennsylvania, Georgia, Texas, Indiana, and Wisconsin.

Fruit rot caused by various organisms.

Table 93. Losses from Fusarium rot of cantaloupe caused by Fusarium sp. as shown by examination of cars at destination by inspectors of the Bureau of Markets, 1920.

Origin of shipment	No. of cars with decay	Range of percentage of decay: No. cars	Range of percentage of decay: Percent	Origin of shipment	No. of cars with decay	Range of percentage of decay: No. cars	Range of percentage of decay: Percent
Arkansas	5	5	3-17	Indiana	4	4	1-35
California	71	62	1-25	Maryland	1	1	2
		6	25-50	New Mexico	2	2	18-21
		3	65-100	North Carolina	1	1	12
Colorado	12	12	1-25	South Carolina	5	5	1-25
Georgia	1	1	33	Washington	1	1	35-95

Total number of cars of cantaloupes with Fusarium rot .. 103
Total number of cars of cantaloupes inspected 577

Table 94. Losses from Rhizopus rot of cantaloupe caused by Rhizopus sp., as shown by examination of cars at destination by inspectors of the Bureau of Markets, 1920.

Origin of shipment	No. of cars with decay	Average percentage of decay	Range of percentage of decay: No. cars	Range of percentage of decay: Percent	Origin of shipment	No. of cars with decay	Average percentage of decay	Range of percentage of decay: No. cars	Range of percentage of decay: Percent
Ark.	5	6	5	1-15	Ind.	3	30	1	85
Ariz.	2	2	2	1-3				2	2
Calif.	99	11	3	50-75	Md.	1	2	1	2
			9	25-45	N. M.	1	3	1	3
			87	1-25	N. C.	1	2	1	2
Colo.	3	16	3	4-30	S. C.	3	40	1	100
Del.	1	30	1	30				2	4-15
					Unknown	1	30	1	30

Total number of cars of cantaloupes with Rhizopus rot 120
Total number of cars of cantaloupes inspected 577

Table 95. Losses from green mold rot of cantaloupe caused by Cladosporium sp., as shown by examination of cars at destination by inspectors of the Bureau of Markets, 1920.

Origin of shipment	No. of cars with decay	Average percentage of decay	Range of percentage of decay: No. cars	Range of percentage of decay: Percent	Origin of shipment	No. of cars with decay	Average percentage of decay	Range of percentage of decay: No. cars	Range of percentage of decay: Percent
Ark.	6	7	6	5-8	Colo.	1	2	1	2
Ariz.	1	10	1	10	Ind.	1	1	1	1
Calif.	39	17	3	50-75	Md.	1	2	1	2
			6	25-50	S. C.	2	15	2	12-18
			30	1-25					

Total number of cars of cantaloupes with green mold rot 51
Total number of cars of cantaloupes inspected 577

Black mold rot caused by Alternaria sp. was reported by inspectors of the Bureau of Markets as follows: Arkansas, 1 car with 15-20%; California, 13 cars with 1-15%, 6 cars with 15-40%, 2 cars with 80-87%, total 21 cars with an average of 19%; Colorado, 7 cars with 3-35%, average 11%; Delaware, 1 car with 13%; Indiana, 1 car with 35%. The total number of cars with black mold rot was 31.

Blue mold rot caused by Penicillium sp. was found by inspectors of the Bureau of Markets in a total of 21 cars, as follows: California, 17 cars with 1-25%, 2 with 20-45%, average in 19 cars 14%; Indiana, 1 car with 2%; unknown origin, 1 car with 30%.

Bacterial soft rot was found by inspectors in 25 cars: Arkansas, 4 cars

with an average of 44%; California, 6 cars with 2-10%, 5 cars with 10-25%, 4 with 30-65%, average in 15 cars 21%; Colorado, 2 cars with an average amount of 11%; Georgia, 1 car with 3-5%; Indiana, 1 car with 25%; Missouri, 2 cars with 2-7%.

Other diseases.

Downy mildew caused by Pseudoperonospora cubensis (B. & C.) Rostow was reported only from New Jersey, where it was general and sometimes destructive. Bureau of Markets inspectors reported its presence in 10 cars of California cantaloupes, as follows: 5 cars with 10-25%, 5 cars with 3-10%, average 12%.

Wilt caused by Fusarium sp. was reported from California, where it occurred only in the sandy regions of the San Joaquin Valley, according to D. G. Milbrath.

Southern wilt caused by Sclerotium rolfsii Sacc. was said to be slightly more important than usual in Texas. It was found in light soils, especially where irrigated.

Root knot caused by Heterodera radicicola (Greef) Müll. was reported from Texas, where it was prevalent in sandy soils, and caused a loss estimated at .5%, and from California, where it occurred in the Imperial Valley and in the vicinity of Turlock in the San Joaquin Valley, according to D. G. Milbrath, who estimated the reduction in yield at 5%.

CUCUMBER

Bacterial wilt caused by Bacillus tracheiphilus EFS.

Bacterial wilt and mosaic seemed to be of about equal importance in 1920. The former was reported from New Hampshire, New York, New Jersey, Pennsylvania, Virginia, Texas, Indiana, Illinois, Michigan, Wisconsin, and Iowa. S. P. Doolittle, who watched cucumbers closely last summer, says of the disease:

> "Very prevalent in Michigan, Illinois, Indiana, and Wisconsin during July and early August. Found in practically all fields visited during this time, about 2 to 4% of the plants being affected. However, no serious losses occurred in any of these states. On Long Island the disease was of considerable importance, the injury varying from 8-10% in most cases, up to 50-70% in fields about Farmingdale."

Losses were estimated as follows by collaborators: New York, 15%; Indiana, 5%; Wisconsin, trace; Iowa, 12%; and as high as 75% and 50% were noted in individual fields in New York and Virginia, respectively.

Dates of first observation of bacterial wilt, 1920:

June 18 ..... Lima, N. Y.
June 24 ..... Marion County, Ind.
July 15 ..... Luzerne County, Pa.
August 3 .....West Epping, N. H.
August 15 .....Madison, Wis.

Nothing on control or resistance was reported.

Mosaic (cause undetermined)

Reports of mosaic have been received from Massachusetts, Connecticut, New York, Pennsylvania, Virginia, Texas, Indiana, Illinois, Michigan, Wisconsin, Iowa, and California.

Average state reductions in yield were estimated by collaborators as follows: New York, 10-15%; Indiana, 3%; and Wisconsin, 7%.

S. P. Doolittle of the Office of Cotton, Truck, and Forage Crop Disease Investigations has prepared the accompanying comprehensive statement of the mosaic situation of 1920:

> "The season of 1920 was characterized chiefly by unusually severe losses from cucurbit mosaic throughout Illinois, Michigan, Wisconsin, and Indiana. The widespread injury from this disease was apparently due to abnormal weather conditions which favored the rapid increase of the cucumber aphids and through their agency the rapid dissemination of mosaic. Widespread infection occurred in Wisconsin, Illinois, Indiana, and Michigan, beginning about July 15. Seventy-five per cent of the fields in Wisconsin and northern Illinois showed from 60 to 100% of the plants affected with mosaic by September 15. Reports and observations indicate that the disease was at least equally as severe in most cucumber growing sections in Michigan and Indiana. The losses this season were more severe than in any year noted by the writer since 1914.
>
> "On Long Island the disease was equally prevalent, all the fields visited about the Farmingdale and Green Lawn sections being practically 100% mosaic on September 1."

Recent studies by Doolittle (Abstract in Phytopath. 11: 47. 1921) have shown that mosaic may be transmitted from cucumber to milkweed, Asclepias syriaca, pepper, Capsicum annuum, and Martynia louisiana, and from these plants back to cucumber. There is also some evidence that pigweed, Amaranthus retroflexus, is susceptible. As the milkweed is perennial it can easily act as an agent in over-wintering the mosaic virus. Doolittle has shown that the wild cucumbers transmit the causal factor through the seed and are one of the principal sources of infection. Considerable success has attended efforts to control mosaic by eradicating wild cucumbers in some of the pickle fields of the Lake States.

Significant results on the relation of temperature to cucurbit mosaic have been reported by Doolittle (Phytopath. 11: 47, 1921).

Angular leaf spot caused by Bacterium lachrymans EFS &. Bryan.

The following summary by S. P. Doolittle conforms with statements received from collaborators.

> "No injury of economic importance resulted from this disease in Michigan, Indiana, Illinois, or Wisconsin as far as the writer was able to determine. Angular leaf spot did not appear in Wisconsin or Illinois until late in the summer and on September 15 was present to some extent in 8-10% of the fields visited. Usually not over 10% of plants affected and then only slight injury."

M. W. Gardner of Indiana says further:

"The marked scarcity of this disease as compared with its prevalence in Heinz fields in 1915, 1916, and 1917 is very striking. All Heinz Company seed is treated in $HgCl_2$ (1-1000 for 5 minutes) and this has practically eliminated this disease from their fields."

Anthracnose caused by Colletotrichum lagenarium (Pass.) Ell. & Hals.

Apparently anthracnose was of very little consequence in 1920. The only states reporting much damage were Georgia, where 85% infection and 5% loss was estimated, and Arizona, where the disease was noted as severe in at least one garden. It was reported in the field also from New Hampshire, New York, Ohio, Indiana, Wisconsin, and Iowa, and was found by market inspectors in cucumbers from Alabama, Delaware, Maryland, and Texas.

S. P. Doolittle reported concerning this disease:

"Situation same as in the case of angular leaf spot. About 2% of fields in Wisconsin showed slight traces of anthracnose late in season but usually only a few plants (less than 1%) were affected. None noted in Illinois. No report of disease from Michigan."

Dates of first observation of cucumber anthracnose, 1920:

August 17 ..... Center Harbor, New Hampshire.
September 5 ..... Madison, Wisconsin.
September ..... Suffolk County, New York.

Downy mildew caused by Pseudoperonospora cubensis (B. & C.) Rostow.

Mildew was reported along the Atlantic Coast from Massachusetts (about same, not serious as it occurred too late), Connecticut, New York (slight injury on Long Island), New Jersey, and Virginia. It was also reported in one greenhouse in Indiana.

Black rot caused by Mycosphaerella citrullina (C. O. Sm.) Gros.

F. C. Meier has reported on this disease in the Fruit and Vegetable Division, Bureau of Markets, Division Letter for May 27, 1920, as follows:

"Black rot caused by Mycosphaerella citrullina has been found frequently on Florida cucumbers this spring, particularly in the hampers marked 'culls'.

"This disease affords an interesting example of the part that the Food Products Inspector may play in contributing to our fund of pathological information, for this fruit rot was first noticed a year ago on specimens that were sent to New York from several of the outlying markets. This fungus, which causes a destructive and widespread blight of the watermelon in Florida, is also responsible for a small portion of the watermelon end rot found on the market.

"On the cucumber, fruit infection apparently occurs as a result of the transfer of spores from diseased vines to injuries on the surface of the fruit. Many cases have been noted where infection has occurred at the wound caused by pulling the cucumbers from the vines. In the

course of experiments conducted in the New York laboratory, it has been found possible to secure infection by means of finger nail injuries after decayed cucumbers on which the fungus was fruiting had been handled."

In a letter to the Survey, dated November 5, Meier states further:

"This is a very interesting disease, particularly as the same fungus is responsible for a large per cent of the stem-end rot of watermelons that originate in south Florida.

"I have also collected the fungus on chayote, various squashes, and on honey dew melon in that state. It was only this year, however, that we have been able really to do any work on the disease. Dr. Brierly informs me that it is the most serious trouble that the cucumber hothouse growers have to contend with in England."

During May and June black rot was found by inspectors of the Bureau of Markets in 39 cars of cucumbers, as shown in the following table:

Table 96. Percentages of black rot of cucumbers caused by Mycosphaerella citrullina reported by inspectors of the Bureau of Markets during May and June, 1920.

State	Number of cars	Average percentage	Shipping point	Percentage of black rot
Florida	33	9.6	Brooksville	2
			Center Hill	20*, 15*
			Leesburg	16, 6
			Tampa	11, 15, 12.5, 9, 26, 6-12, 6-12*
			Wauchula	12-20 (An), 14, 25, 9*, 3*, 3*, 7*, 7*, 5, 3, 8, 8, 10, 2, 2, 5, 1.5, 6, 8
			Unknown	8-10, 3-5
Alabama	2	3	Mobile	2-4 (Ba), 2-3 (C)
Louisiana	1	5	New Orleans	5 (Ba)
Texas	3	4	Jacksonville	t, 4-5 (Bm), 7

*Cause of decay not given, probably Mycosphaerella.
(An) - associated with angular leaf spot.
(Ba) - mostly bacterial rot associated with Mycosphaerella.
(Bm) - associated with black mold.
(C) - associated with cucumber rot.

Other diseases.

Scab caused by Cladosporium cucumerinum Ell. & Arth. - Michigan (one

location, St. Clair County, but not causing serious injury), California (cause of considerable rot, 3% reduction for state).

Wilt caused by Fusarium niveum EFS. - Ohio (less).

Powdery mildew caused by Erysiphe cichoracearum DC. - Indiana (in greenhouse, negligible), and California (10% loss in 800 acres in Alameda County).

Leaf spot caused by Alternaria brassicae nigrescens Pegl. - New Jersey.

Root rot caused by Sclerotinia sp. - New York (in greenhouse, plants appear healthy till blossoming time when they go down, with little or no fruit).

Root knot caused by Heterodera radicicola (Greef) Müll. reported as troublesome in greenhouses in Massachusetts, Ohio, and Indiana. In sandy soils in Texas causing 5% loss.

Watery soft rot caused by Sclerotinia libertiana Fckl. - reported in the field from Idaho, where it was noted in gardens after fall rains began, and reported by market inspectors on cucumbers from Florida (22 cars with 8% decay), Illinois (1 car with 18%), and Maryland (2 cars with 40%).

Fusarium rot caused by Fusarium sp. was found in carlots in cucumbers from Delaware (1 car, 20% decay), Florida (2 cars, 16%), Maryland (3 cars, 29%), South Carolina (6 cars, 11%), Texas (4 cars, 12%).

Soft rot of fruit caused by Rhizopus sp. - reported by market inspectors as follows:

Table 97. Losses from soft rot of cucumbers caused by Rhizopus sp., as reported by inspectors of the Bureau of Markets, 1920.

Origin of shipment	No. of cars with decay	Average percentage of decay	Origin of shipment	No. of cars with decay	Average percentage of decay
Delaware	2	15	South Carolina	7	9
Florida	8	15	Texas	6	9
Maryland	2	40	Unknown	1	2
New York	3	24			

Bacterial soft rot was one of the principal decays found in cucumber shipments during 1920.

PUMPKIN

Bacterial wilt caused by Bacillus tracheiphilus EFS. - Ohio (more than usual).

SQUASH

Mosaic (cause undetermined) - Connecticut (on summer squash, one report).

Bacterial wilt caused by Bacillus tracheiphilus EFS. - New York (probably occurs wherever squashes are grown, but reported from Albany County only, July 17), Indiana (local, negligible), Iowa (trace).

Wilt caused by Fusarium sp. - Texas (very important, reduction in yield 10%; very moist season).

Root rot caused by Ozonium omnivorum Shear - Texas (less important than usual).

WATERMELON

Anthracnose caused by Colletotrichum lagenarium (Pers.) E.& H.

Table 98. Percentages of anthracnose of watermelon in shipments from various states as determined by food-products inspectors of the Bureau of Markets August 27 to September 10, 1920. (For records prior to August 27 see Pl. Dis. Bul. 4: 62, 95.)

Origin of shipment	Market where inspected	Percent of anthracnose	Origin of shipment	Market where inspected	Percent of anthracnose	Origin of shipment	Market where inspected	Percent of anthracnose
Ala.	Pittsburgh	15	Mo.	Detroit	11	S. C.	New York	11
	"	4		"	2		"	90
		Av. 10		Indianapolis	9		Philadelphia	18
Ark.	St. Paul	9		Milwaukee	50		Pittsburgh	33
	"	2		Pittsburgh	85		"	35
	"	10		"	27		"	20
	"	57		"	20		"	47
	"	43		"	10		"	2
	"	55			Av. 30		Washington	20
		Av. 39	N. C.	Baltimore	100			Av. 31
Del.	Boston	40		"	20	Va.	Boston	30
	Cleveland	100		"	65		"	90
	New York	85		"	75		"	58
	Philadelphia	30		"	40		New York	25
	Pittsburgh	87		New York	10		"	20
		Av. 68		"	95		"	10
Ga.	New York	30		Pittsburgh	22		"	20
	"	24		"	20		"	75
	"	45		"	60		"	100
	Pittsburgh	45		"	2		"	60
	"	15			Av. 46		"	100
		Av. 16	Okla.	New Orleans	25			Av. 53
Ind.	Pittsburgh	8		"	15	Unkn.	Philadelphia	10
La.	Pittsburgh	20		"	95		"	60
Md.	Boston	100			Av. 45		"	37
	Cleveland	65	Tenn.	Pittsburgh	30		Pittsburgh	12
	New York	75	S. C.	Baltimore	35		"	18
	Philadelphia	20		"	10		"	15
	"	90		New York	30		"	17
	"	20		"	63		"	8
		Av. 51		"	35		"	65
Mo.	Buffalo	30		"	10			Av. 27
	Detroit	60						

In 1920 Mississippi and Arizona reported the presence of anthracnose to the Survey for the first time. In both states the disease was said to be local in occurrence, but while it caused slight damage in Mississippi, in Arizona the injury due to it was severe in the one case reported. In Alabama it caused as much as 5-15% loss in some fields and in Texas the reduction in yield for the state was estimated at 1%. In most cases it was unimportant as a field disease, however, and caused most loss on melons in transit. Table 98 shows the amounts of anthracnose found in cars examined between August 27 and September 10.

Stem-end rot caused by Diplodia sp.

Stem-end rot was also of little importance in the field, although it caused some damage in Georgia and Mississippi. In Indiana the disease commonly followed blossom-end injury on stunted or malformed fruits, but did not occur as a stem-end rot.

Stem-end rot caused considerable loss of melons in transit, as shown in Table 99, which gives the percentages of affected fruit found by inspectors in cars examined during the period from August 6 to September 10.

Table 99. Percentages of stem end rot of watermelon found in shipments examined at various markets by inspectors of the Bureau of Markets August 6 to September 10, 1920. (For records before August 6 see Pl. Dis. Bul. 4: 63.)

Origin of shipment	Market where inspected	Percent stem-end rot	Origin of shipment	Market where inspected	Percent stem-end rot	Origin of shipment	Market where inspected	Percent stem-end rot
Ala.	Pittsburgh	9	Ga.	Milwaukee	5	Ga.	Pittsburgh	3
	"	7		New Orleans	2		"	4
		Av. 8		"	18		"	17
Ark.	Kansas City	3		"	2		"	8
	St. Paul	25		"	11		"	3
	"	11		"	13		"	17
	"	16		Pittsburgh	13		"	9
	"	6		"	2		"	22
	"	2		"	10		"	8
	"	3		"	6		"	16
	"	13		"	18		"	17
	"	2		"	5		New Orleans	25
		Av. 9		"	3		"	5
Ga.	Buffalo	37		"	10		"	35
	"	68		"	6		"	7
	"	18		"	7		"	50
	"	45		"	9		"	15
	"	55		"	19		"	28
	"	30		"	5		"	10
	"	25		"	9		New York	45
	"	50		"	4		"	11
	Cleveland	18		"	27		"	40
	Indianapolis	20		"	19			Av. 18
	"	11		"	17			

Origin of shipment	Market where inspected	Percent stem-end rot	Origin of shipment	Market where inspected	Percent stem-end rot	Origin of shipment	Market where inspected	Percent stem-end rot
N. C.	Baltimore	5	S. C.	Pittsburgh	7	Unkn.	Buffalo	10
	"	5		"	18		Chicago	2
	New York	20		"	12		New York	50
	Pittsburgh	2		"	22		"	1
	"	9		"	2		"	15
	"	15		"	13		"	10
	"	2		"	9		"	20
	"	20		"	92		Omaha	5
	"	5			Av. 18		Philadelphia	37
	"	5	Tenn.	Pittsburgh	3		Pittsburgh	11
		Av. 9	Texas	Kansas City	15		"	28
S. C.	Buffalo	2		Omaha	15		"	65
	"	2		"	11		"	15
	New York	20		St. Louis	3		"	2
	"	20		"	5		"	11
	"	30			Av. 10		"	25
	"	2	Va.	Boston	2		St. Louis	5
	Philadelphia	28		Pittsburgh	17			Av. 18
	Pittsburgh	3			Av. 10			

Total number of cars inspected 656
Total number of cars with stem end rot 123
Average amount of stem end rot in 123 cars 15.6%

Blossom-end rot (cause unknown).

Blossom-end rot was reported from Texas (fairly important in poorly drained fields, reduction in yield .5%), Iowa (more, 2% loss), Idaho (probably due to Fusarium sp., important only on late crop).

While blossom-end rot was comparatively unimportant as a transit disease, it caused some loss, especially in South Carolina melons. It was found by Bureau of Markets inspectors in 16 cars, as follows: Georgia, 1 car with 2%; North Carolina, 1 car with 4-5%; South Carolina, 6 cars with 2-5%, 7 with 9-15%, 1 with 25%, total 14 cars with an average of 9%.

Wilt caused by Fusarium niveum EFS.

Fusarium wilt was apparently unimportant or only locally severe in most states, but it was said to be serious in Texas, Indiana, Iowa, and Utah. The loss in Texas, where the disease was found only in regions with sandy soils, was estimated at 4%, and in Utah at 3%. In Indiana the disease is the limiting factor in melon growing, and has caused a great reduction in acreage by rendering suitable lands unfit for this crop, according to M. W. Gardner. The 1920 record was the first received by the Survey from Utah, from which state B. L. Richards reported as follows:

"The Fusarium wilt has been responsible this year for serious losses to the crop in a number of truck-crop districts in the State. Davis and Salt Lake Counties have suffered very severely. A survey of the former county shows an average loss of 10 to 15% of the crop. The yield for the state was reduced approximately 3%. Irrigation rapidly distributes the disease in the field and from field to field. The trouble is reported to be definitely increasing in the state."

Other diseases.

Leaf blight caused by Alternaria brassicae nigrescens Pegl. - Indiana (Knox County, one field. Not destructive. Occurs where watermelons follow cantaloupes or are grown in same field with cantaloupes).

Leaf rot caused by Cercospora citrullina Cke. - Texas (negligible).

Mosaic (cause undetermined) - Michigan (Allegan County).

Bacterial wilt caused by Bacillus tracheiphilus EFS. - Ohio (more prevalent and more serious than ever before), California (San Fernando Valley; destroyed young plants during June; reduction in yield 2%).

Rot caused by Alternaria sp. - Whitman County, Washington.

Stem-end rot caused by Rhizopus sp. - reported by F. C. Meier as follows, (Bureau of Markets Div. Letter, Sept. 2, 1920:8):

"This disease is frequently found in shipments from all of the states in which watermelons are grown. It is quite different in appearance from the rot caused by Diplodia, the stem-end rot disease that is so common in shipments from the southeastern states."

DISEASES OF COTTON

Anthracnose caused by Glomerella gossypii (South.) Edg.

More anthracnose than last year was reported from Tennessee, North Carolina, and Louisiana, but in Georgia, Alabama, and Mississippi less damage than usual apparently occurred. In North Carolina it was present in all cotton growing counties but was most destructive in those of the Coastal Plain. In Mississippi it was mostly in the so-called Delta Region.

The injury took the form of a rotting of the bolls for the most part. As high as 75% infected bolls were observed in North Carolina and 100% in Louisiana. The accompanying map shows the estimated percentage losses and further estimates will be found in Supplement 18 of this Bulletin.

Collaborators had the following to report regarding weather conditions:

North Carolina (Jehle): "Late rains and warm weather were favorable for the disease."

Georgia (McClintock, Sept. 1): "Very small per cent in middle, Georgia, probably due to dry weather early in the season."

Mississippi (Neal): "Weather has not been favorable for its spread this season."

Louisiana (Edgerton): "Very abundant in some sections due to excessive rainfall."

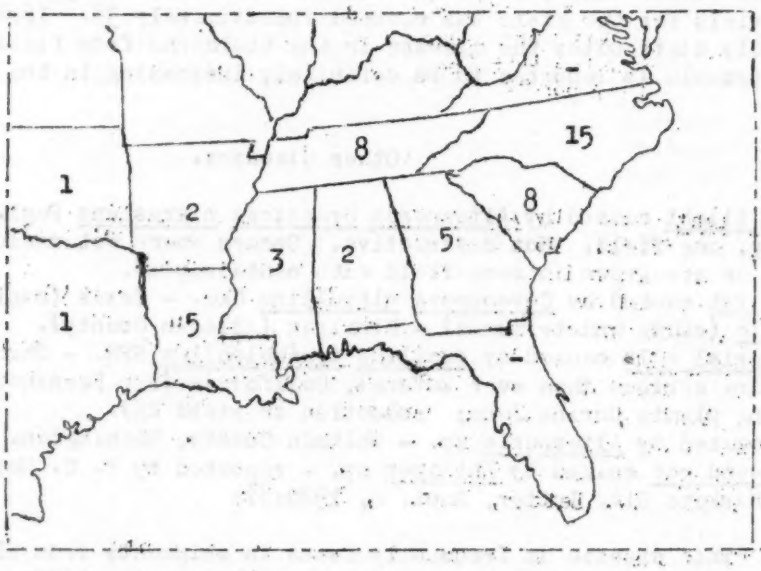

Fig. 51. Estimated percentage reduction in yield of cotton from anthracnose, 1920.

Dates of first observation;

June 20 ..... Mississippi.
July ..... Baton Rouge, Louisiana.
July ..... Arkansas.
August 31 ..... Chadbourne, North Carolina.

In Arkansas it was reported as especially severe on the variety Half and Half, the seed of which was brought in from east of the Mississippi River.

Wilt caused by Fusarium vasinfectum (Atk.)

Wilt was reported occurring on sandy soils in all the cotton states of the South as far west as Texas. It was also reported from California (one case reported by H. P. Severin of the Experiment Station at Berkeley). In general it was prevalent in about the normal amounts although in states along the Gulf Coast and in Arkansas somewhat more than usual was reported.

Losses by states have been estimated as follows:

7% ..... Louisiana, Arkansas.
5% ..... North Carolina, Alabama, and Mississippi.
3% ..... South Carolina.
2% ..... Georgia.
Less than 1% ..... Tennessee, Texas, Oklahoma.

In Alabama from one-fourth to one-half of the plants in some counties were affected and in southern South Carolina hundreds of acres were seen with 5-10% dead or dying plants.

The following was reported on varietal susceptibility:

North Carolina (Jehle): "Losses in many fields reduced by planting Dixie and Dixie-Triumph."

Georgia (McClintock): "Serious only on certain varieties and crosses of varieties. Resistant varieties quite largely planted."

Mississippi (Neal): "Tri-Cook has given good results in the hill section and Webber 49 is semi-wilt resistant and largely planted in the Delta."

Arkansas (Elliott) "Resistant - Dixie, Dix-Afifi, and Dixie-Mebane."

Angular leaf spot caused by Bacterium malvacearum EFS.

Leaf spot was reported from practically all of the cotton states. It was relatively unimportant in the eastern portion of the cotton belt but in Texas and Arizona it was the most serious cotton disease and in Arkansas also it was very severe and widespread. In Texas, where 2% loss was estimated, all forms of the disease, leaf spot, black arm, and boll rot were very prevalent, especially on poorly drained lands. In the Salt River Valley of Arizona it presents a serious problem, as the long staple Pima (Egyptian) cotton that is grown there is very susceptible to attack by B. malvacearum and last year it was estimated that 15-20% loss occurred in Arizona as a result of the disease.

Root knot caused by Heterodera radicicola (Greef) Müll.

Root knot occurred commonly in cotton fields on sandy soils in the South. Its close association with Fusarium wilt makes it very difficult to clearly separate the losses caused by the two troubles. Judging from the reports received for 1920, the largest losses occurred in Georgia where 3% reduction in yield was estimated. The Carolinas, Alabama, and Arkansas also reported considerable injury in sandy soils and a loss of 1% was estimated for these states. Collaborators in the other cotton states regarded the disease as unimportant.

Phoma blight caused by Phoma sp.

This new cotton disease was reported from Arkansas for the first time by J. A. Elliott (Phytopath. 10: 48. 1921. Abst.). It appeared in June in west-central Arkansas along the Petit Jean River in Logan and Yell Counties, and made rapid progress during a period of cool, wet weather. In small areas all plants were killed and in others the stand was greatly reduced. A change of weather conditions checked the disease. All parts of the plant above ground were attacked and progress of the fungus within the tissues was very rapid when the weather was favorable for it.

It is suggested that a sharp watch be kept for the appearance of this disease in other parts of the South this year.

Malnutrition (non-parasitic).

Malnutrition, or rust, as it is known in some sections, caused less

damage than usual in most states, according to reports received. In Georgia it was said not to have been observed since 1918, due probably to the fact that farmers had been using more potash in their fertilizers. Moist weather in Louisiana and Arkansas prevented its occurrence to any great extent, although it was said to be common on the poorer soils in the latter state. In Louisiana it is reported as a serious trouble only during very dry seasons. In Mississippi the disease caused premature defoliation, but apparently had little effect on the yield, and seemed to hasten the maturity of the bolls. Reports in the Weekly Crop Notes of the Bureau of Crop Estimates indicate that "rust" was rather important in South Carolina, and it was also reported from Florida and Oklahoma.

Other diseases.

Leaf spot caused by Cercospora gossypina Cke. - Texas (unimportant, traces; Dallas and Bell Counties).

Rust caused by Aecidium gossypii E. & E. - Texas (unimportant, trace; Webb and Hopkins Counties).

Boll rots were apparently generally favored by moist weather and low temperatures according to reports in the National Weather and Crop Bulletin and the Weekly Crop Notes of the Bureau of Crop Estimates, during August and September. Boll rot or "black boll" due to Diplodia gossypina Cke. was reported by collaborators from Louisiana (worse than usual, worse than last year all over the state, due to excessive rainfall; reduction in yield 2-5%; first appeared in August at Baton Rouge, most injurious during August and September), and Arkansas (25% injury, 3% loss; first report in August). Fusarium sp. also caused some injury in Arkansas, which is included in the above estimate.

Root rot caused by Ozonium omnivorum Shear - Texas (very important as usual in all black, waxy clay soils, reduction in yield 8%).

Damping-off and sore-shin caused by Rhizoctonia sp. - Mississippi (damping-off important, more so than usual or than last year; rather general; reduction in yield 2%; disease often causes poor stands, especially on rich, poorly drained soils; first reported May 22), Texas (sore-shin unimportant).

DISEASES OF SUGAR CANE

Mosaic (cause undetermined).

More mosaic was reported from our southern states last year. Collaborators' reports indicate that it is spreading and becoming more important, and E. W. Brandes of the Office of Sugar Plant Investigations says:

> "In general, our survey shows a rapid spread of mosaic everywhere but especially in the counties surrounding Grady in Georgia and in the Bayou La Fourche district of Louisiana."

Georgia (McClintock): Reported from Grady and Thomas Counties, causing serious damage. Cutting out diseases stalks during past season has not controlled the disease.

(Brandes) Occurred in Brooks, Mitchell, Decatur, and Colquitt Counties also.

Florida (Brandes): Escambia, Gadsden, Jackson, and Liberty Counties. Eradication was successful in Palm Beach County, no mosaic being reported in 1920. We have reports on 250 properties in this county.

Alabama (Brandes): Occurred in Baldwin County.

Mississippi (Neal): This disease is now present in 14 counties. During the past season 276 fields have been inspected and 34 of these have mosaic ranging from a trace to 100% or an average of about 7% to 8% for the state. The actual reduction in yield for the state does not exceed a trace. First observed this year in June at Gulfport.

Mississippi counties where mosaic was found.

1. Harrison
2. Jackson
3. Pearl River
4. Stone
5. George
6. Greene
7. Lamar
8. Marion
9. Walthall
10. Pike
11. Covington
12. Wayne
13. Lauderdale
14. Kemper

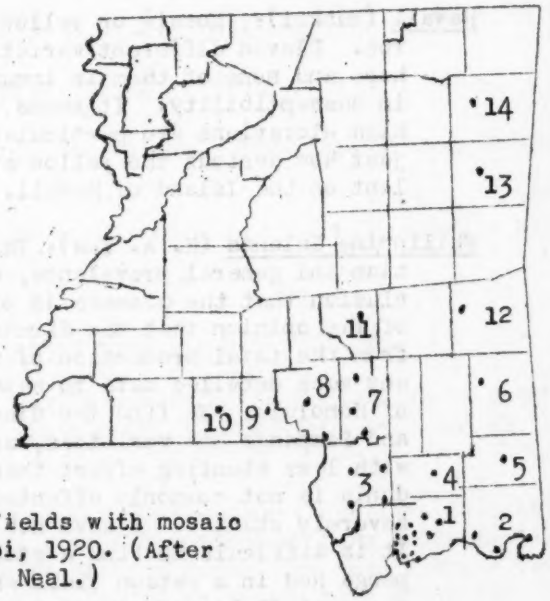

Fig. 52. Location of cane fields with mosaic in southern Mississippi, 1920. (After map furnished by D. C. Neal.)

Louisiana (Edgerton): Disease has spread very rapidly this year. It is in all the cane i. the river section and is beginning to show in other parts of the state. Very important, probably affecting about half the plants in the state and reducing the yield 3-5%. First observed in April at New Orleans and injurious all the season.

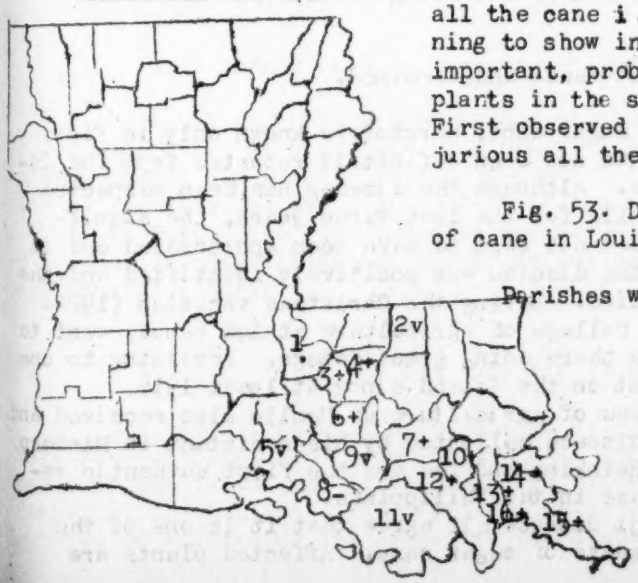

Fig. 53. Distribution and severity of mosaic of cane in Louisiana. (After map by C.W. Edgerton).

Parishes where mosaic occurred:

1. Pointe Campee
2. St. Helena
3. W. Baton Rouge
4. E. Baton Rouge
5. Iberia
6. Iberville
7. Ascension
8. St. Mary
9. Assumption
10. St. James
11. Terre Bonne
12. La Fourche
13. St. Charles
14. Orleans
15. Plaquemines
16. Jefferson

Porto Rico (Julius Matz): Mosaic has become widely spread all over the Island, although the eastern end is still free. The intensity of infestation is less, however. Growers have avoided infected seed wherever it was possible to obtain it disease free. Most of the infection now comes from the diseased stubble, and as these do not do well when infected they will be eliminated in the course of time. The situation is, therefore, not so bad as at the beginning of the eradication campaign. The disease has been eradicated from several large estates during the year.

The variety Uba is not susceptible and is making a good reputation for itself.

Hawaii (Kunkel): Mosaic or yellow stripe is next in importance to root rot. Eleven different varieties of cane are grown commercially here and none of them is immune but they do show great differences in susceptibility. It seems that the varieties that are grown at high elevations are particularly susceptible. I am not yet sure just how serious the yellowstripe is. It seems to be most prevalent on the Island of Hawaii.

Philippine Islands (H. A. Lee): This disease is of widespread distribution and general prevalence, and these facts lead me to the conclusion that the disease is of long duration in this country. I am of the opinion that the disease causes a large percentage of loss from the total production of this country, but as yet do not have any such detailed data to show this as was presented by Dr. Lyon of Honolulu. We find the disease very common upon the Luzon White and Pampanga Red varieties, and also upon Louisiana Stripe, but with less stunting effect than on the native canes. Yellow Caledonia is not commonly affected but when affected seems to be very severely stunted. I have not seen H 109 to be affected as yet. It is difficult to find a stool of either the Luzon White or Pampanga Red in a ratoon field which is not affected. The same holds for most fields of plant cane of these varieties after about six months. These varieties are the most generally planted here.

"Fiji disease" cause undetermined.

This destructive malady of sugar cane, heretofore known only in Fiji, New Guinea, and New South Wales, has now been definitely reported from the Island of Mindoro in the Philippines. Although the disease has been suspected in these Islands by persons at Manila for the last three years, the significance of its possible presence does not seem to have been appreciated and it was not until January, 1921 that the disease was positively identified and the seriousness of the situation realized. During the Christmas vacation (1920-21) Prof. Otto A. Reinking of the College of Agriculture at Los Banos, went to Mindoro and found the Fiji disease there doing great damage. According to one of the planters it has been present on the Island since at least 1916.

Prof. H. A. Lee of the Bureau of Agriculture at Manila also received and identified specimens of the Fiji disease collected by his assistant in Mindoro in January 1921. The reports of Reinking and Lee are the first authentic records of the presence of the disease in the Philippines.

Written accounts of the Fiji disease all agree that it is one of the most, if not the most, serious disease of sugar cane. Affected plants are

dwarfed, produce many distorted leaves, many of which bear galls, and die early. The disease is very infectious and the organism is present in all parts of an infected plant, even if only a few leaves of one stalk show symptoms.

The causal organism, which is thought to be a Myxomycete of the plasmodiophora type, seems to be able to live for a considerable length of time in the soil and is readily carried from field to field with particles of soil. Marked differences in varietal susceptibility appear to exist. The trouble has not been studied to any great extent.

References:

1910 Muir, F. Hawaiian Planters Record 3: 197.

1910 Lyon, H. L. Hawaiian Planters Record 3: 200-205.

1911 Lyon, H. L. Hawaiian Planters Record 4: 230-232, 300.

1915 Lyon, H. L. Fiji disease in New Guinea. Hawaiian Planters Record 12: 200.

1920 Reinking, Otto A. Diseases of Sugar cane in the Philippines - Fiji disease. Sugar News 1: 17-19.

Gumming caused by Bacterium vascularum (Cobb) EFS.

A further statement on gumming, which was found in Porto Rico by Matz in February, 1920 and reported by him (Phytopath. 10: 429-430, 1920 and Pl. Dis. Bul. 4: 111, 1920), has been received.

> "In my work with gumming of sugar I have come to believe that this disease here, although identical with the gumming of cane in Australia and Pernambuco, is not the same as that of Java. The Java disease is similar to one which I have found here and is caused by a Plasmodiophora." (See dry top rot in this summary).

Root rots caused by Marasmius plicatus Wak. and other fungi.

Root rot probably caused a loss of about 5% for Louisiana, according to C. W. Edgerton. It was present in practically all fields affecting from 1-25% of the plants and as high as 50% in some fields. It was thought that the loss was not so great as usual on account of the wet season.

In Porto Rico root diseases were common and of importance, according to Matz, and in the Philippines Marasmius was said to be present but not causing any special injury.

Top rots due to various causes.

Dry top rot thought to be caused by Plasmodiophora sp., was reported by Matz for the first time from Porto Rico. Specimens were collected from most parts of the Island and it was found on the varieties Rayada, Cavengerie, D 109, Otaheite, Crystallina. The organism occurs in the vessels of the vascular bundles of sugar cane and causes stunting and drying of top leaves.

A top rot which is considered as the same as the one described by Wakker from Java in 1890, is found in the Philippines according to H. A. Lee who reported as follows:

> "The disease is localized on a few of the larger estates which have introduced cane from Java about five years ago. It causes a great amount of damage in affected fields and we know of one field which had to be plowed over and was a total loss due to this disease. The order of susceptibility of varieties as we have observed it is Yellow Caledonia, Louisiana Stripe, Luzon White, and Pampanga Red. H 109 we have not yet seen to be affected."

Top rot (non-parasitic) - Porto Rico (common, small loss, occurs on late shoots which are shaded by the taller and older stalks).

Other diseases.

Red rot caused by Colletotrichum falcatum Went - Louisiana (of considerable importance) and Mississippi.

Iliau caused by Gnomonia iliau Lyon - was reported by Edgerton from Louisiana as causing slight damage in the northern and central parts of the state.

Pineapple disease caused by Thielaviopsis paradoxa (De Seynes) Von Höhnel - Mississippi and the Philippine Islands. According to H. A. Lee there is much loss in the Philippines from this disease. Many fields had to be replanted or abandoned due to lack of seed piece germination.

Wilt caused by Cephalosporium sacchari Butler - reported by H. Atherton Lee from the Philippines as follows:

> "This disease reported previously only from India and the Union of South Africa was also sent in to me from Mindoro. The fungus which was isolated proved the identity of the disease. It is not of widespread occurrence but causes entire killing of a cane when once affected."

Rust (Puccinia kuehnii) - Philippines, causing slight injury to the variety Louisiana Stripe.

Smut caused by Ustilago sacchari Rab. was reported by mistake from New Mexico in 1919 (Pl. Dis. Bul. Suppl. 11: 287. 1920). As far as we know this serious cane disease is not present in the United States.

In 1920 it was reported from the Philippines by H. Atherton Lee as follows:

> "This disease is also of widespread distribution on Luzon. It affects especially the Luzon White and Pampanga Red varieties. Yellow Caledonia, H 109, and Louisiana Stripe I have not seen affected by the disease. The disease is a main factor which prevents ratooning of succeptible canes in the Philippines. Inasmuch as Pampanga Red and Luzon White have been the most commonly grown on Luzon, ratooning of cane has not been generally practiced here. I have seen a ratoon field in which four out of five plants were affected."

Sheath spot caused by Bakerophoma sacchari - observed by Lee in the Philippines causing slight injury to the variety Louisiana Stripe.

Leaf spot - cause undetermined - on old leaves of Louisiana Stripe in

the Philippines.

Ring spot caused by Leptosphaeria sacchari Van B. de H. - Porto Rico (common, of no consequence).

Eye spot caused by Helminthosporium sacchari Butler - Porto Rico (common, of no consequence).

DISEASES OF SUGAR BEET

Leaf blight caused by Cercospora beticola Sacc. was reported by collaborators from Wisconsin, Iowa, Utah, and California, and by W. W. Robbins from western Nebraska, Montana, and Colorado, in the northern part of the state and the Arkansas Valley. It was of slight importance except in Iowa, where it affected 20% of the fields and caused a reduction in yield of 1% and in Morgan and Logan Counties and the Arkansas Valley in Colorado, where the loss was estimated at 1-2%. In Utah it occurred only in the Provo district in Utah County.

Curly top (cause not definitely determined). The Plant Disease Bulletin, Supplement 10: 254, curly top was erroneously reported as synonymous with mosaic, whereas they are two distinct diseases and should be reported as such. In 1919 curly top was reported by collaborators from Colorado, Idaho, and Washington; by D. G. Milbrath from California; and by the Office of Sugar Plant Investigations as occurring on specimens received from California, Utah, and Idaho. It was generally prevalent and very severe in Idaho, causing a loss estimated at 20%. In California, in the San Joaquin Valley, it was said to cause an almost total loss.

During 1920 it was reported from Idaho and California only, in both cases as less important than in the previous year. The loss in Idaho was estimated at 8%. From California it was reported by Eubanks Carsner as follows:

> "Curly-top varies very greatly in the amount of damage it does. According to my observation the disease occurs to some extent every year in every beet growing region of California. It is always more serious in the inland regions, where the temperatures are high, than in the cooler coastal districts. I made no extensive survey during the season of 1920, but my impression from reports which I consider reliable is that in general it was much less destructive during this past season than in 1919. To emphasize my point that the damage occurs each year but varies in amount I may state that several fields which came under my observation showed 100% of the plants diseased at the latter part of the past season, though of course not all of them were so badly affected as to make them worthless. During the season of 1919 I observed the most serious losses of any season for several years. Many hundred of acres were a total loss."

Mosaic (cause not definitely determined) was reported in 1919 from Colorado, and by the Office of Sugar Plant Investigations on specimens from Kansas, Colorado, and California. The disease was abundant in Colorado, but the amount of injury due to it was not determined.

In 1920 mosaic was reported from northern Colorado by W. W. Robbins (Phytopath. 11: 48. 1921. Abst.) as occurring in steckling and seed beet fields, and to a slight extent in commercial fields also. Robbins reported studies to show that diseased mother beets may act as centers of infection and suggests that separation of steckling and seed fields may be helpful in control. Accord-

ing to the Office of Sugar Plant Investigations great care should be exercised to select only healthy beets for seed production in the first place, and they should never be taken from fields that have any considerable percentage of mosaic in them.

Downy mildew caused by Peronospora schachtii Fckl. was reported from California as causing little damage.

Rust caused by Uromyces betae (Pers.) Tul. was reported as of slight importance from Kansas and California.

Leaf spot and root rot caused by Phoma betae (Oud.) Fr. were reported from Utah by B. L. Richards. The disease is a very important one in that state although it was less so last year than usual. The probable loss in 1920 was estimated at 1%. The root rot caused a loss of 1% in Idaho also. The leaf spot (reported as Phyllosticta sp.) was said by W. W. Robbins to occur occasionally in Colorado, western Nebraska, Wyoming, and Montana, and the root rot caused slight losses in all silos in the same region.

Rhizoctonia root rot caused by Corticium vagum solani Burt was reported from Ohio and Minnesota, where it was unimportant. Together with Phoma rot Rhizoctonia caused slight losses in Colorado, western Nebraska, Wyoming, and Montana, according to W. W. Robbins. A serious new type of dry rot caused by Rhizoctonia was reported from northern Utah and southern Idaho by B. L. Richards (Phytopath. 11: 48. 1921).

Black root caused by various fungi was reported by W. W. Robbins as follows:

> "Black root (caused chiefly by Phoma and Rhizoctonia) occurred in some degree in all sugar beet districts of northern Colorado, western Nebraska, Wyoming, and Montana. Severity of disease depended principally upon soil type and cultural practice. In the majority of fields there was some loss of seedlings from black root; the loss in many instances is so slight as to make no reduction in stand; in others it caused serious reduction of stand. Estimated reduction in yield is 1%."

Scab caused by Actinomyces scabies (Thax.) Güssow was reported from Wisconsin and Idaho as unimportant.

Tuberculosis caused by Pseudomonas beticola was reported by W. W. Robbins as prevalent in Morgan and Logan Counties in Colorado, causing losses through reduction in the quality of the root, rather than through reduction in yield.

Tip rot, cause unknown, occurred occasionally in northern Colorado, Nebraska, Wyoming, and Montana, according to W. W. Robbins.

The sugar beet nematode, Heterodera schachtii Schmidt, was reported from Utah as a very important trouble, and from California by Eubanks Carsner who stated that it was widespread in that state.

TOBACCO

Angular-spot caused by Bacterium angulatum Fromme & Murray.

Angular-spot was reported from Virginia, Kentucky, and Tennessee, and its occurrence is also suspected in Ohio. Prior to 1920 it had been reported to the Survey only from Virginia, where it was first noticed in 1917, although undoubtedly present before. In that year a serious outbreak occurred in Halifax County which caused the investigation of the disease (Fromme, F. D. and Murray,

T. J. Journ. Agr. Res. 16: 219-228. Feb. 24, 1919) with the result that it was found throughout the tobacco growing region of south-central Virginia. It is now known to occur all over the state, although it causes most damage in the south-central portion. In 1918 it was comparatively unimportant, but in 1919 and 1920 it became increasingly serious, causing losses estimated at more than 10% in 1919 and at 20% in 1920, according to Fromme. In 1920 angular-spot was found to be present in more than 80% of the fields inspected in Virginia.

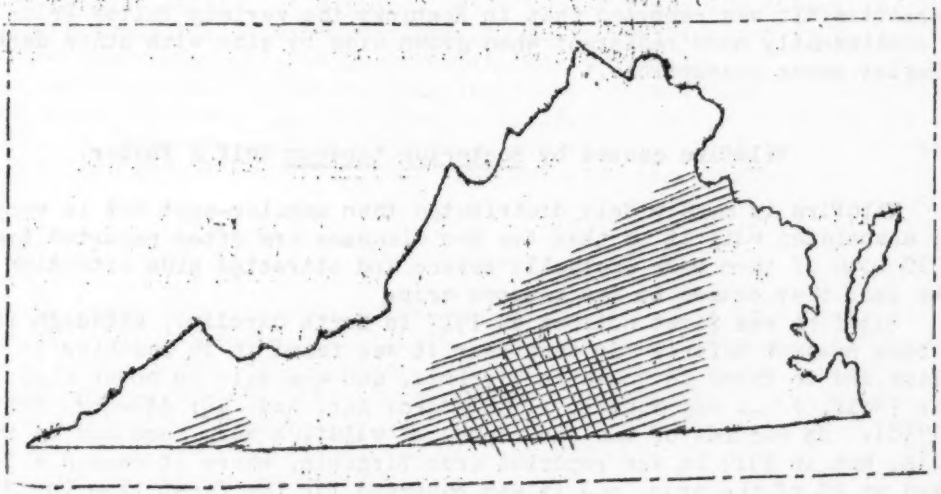

Fig. 54. Map showing distribution of angular-spot of tobacco in Virginia, according to Fromme. Heavy shading indicates regions of greatest severity.

In Kentucky in 1920 angular-spot was prevalent in the Burley and dark tobacco sections (see Pl., Dis. Bul. 4: 52 and 79) and together with wild fire caused a loss estimated at 25%. In Tennessee, according to J. U. Gilmore of the office of Southern Field-Crop Insect Investigations, the "Black Patch" tobacco in the vicinity of Clarksville suffered considerable loss due to wild fire and angular-spot.

The disease was reported in 1919 from North Carolina by F. A. Wolf and E. G. Moss, as follows (N. C. Dept. Agr. Bul. 40: 25. Dec. 1919):

> "Within North Carolina it (angular-spot) was fiest observed during the past season. It has been collected in Granville, Vance, Wake, Lee, Moore, and Johnston Counties and is probably quite generally distributed throughout the state."

The disease was first noticed in Virginia on May 25, in plant beds at Charlotte Court House, Charlotte County, but it caused greatest damage during August, when there was a period of excessive precipitation from the first to the twentieth. In Kentucky it was most injurious from July 10-13, and from August 15 to harvest. The severity and spread of angular-spot are directly connected with the weather conditions. It is said (Fromme and Murray, l. c.) that "Rainfall is an important aid to infection, and the development of the organism within the tobacco leaf is apparently dependent to a marked degree on those predisposing factors which promote a rapid and vigorous growth of the host."

Control measures are still in an experimental stage, but seed treatment with a 2% solution of formaldehyde, supplemented by the use of clean cloth for the plant bed cover, rotation and burning or steaming of the bed, and field

rotation, is recommended by Fromme and Wingard (Phytopath. 11: 48-49, January, 1921). As a result of a seed treatment campaign conducted by the Virginia Experiment Station it is probable that more than 3,000 farmers will use treated tobacco seed in Virginia in 1921.

According to F. D. Fromme, "tests made in 1919 of a number of varieties showed some differences in susceptibility to angular-spot, but none was sufficiently resistant to give any promise of satisfactory control through choice of varieties." It was reported that in Kentucky the variety Yellow Prior "has been consistently more resistant when grown side by side with other dark strains. All Burley seems susceptible."

Wildfire caused by Bacterium tabacum Wolf & Foster.

Wildfire is more widely distributed than angular-spot but is very commonly associated with it so that the two diseases are often reported together. In 1920 both of them were unusually severe and attracted wide attention because of the loss they caused to the tobacco crop.

Wildfire was first noticed in 1917 in North Carolina, although it may have been present before. In that year it was found in 19 counties in North Carolina and in three in southern Virginia, and was said to occur also in Wisconsin (Wolf, F. A. and Foster, A. C. Journ. Agr. Res. 12: 449-458. February 18, 1918). No records of the occurrence of wildfire were received by the Survey in 1918, but in 1919 it was reported from Virginia, where it caused a loss estimated at 2% of the crop, and it was observed for the first time in Connecticut.

In 1920 the disease was reported from Massachusetts for the first time. It was also more prevalent in Connecticut than ever before and of unusual severity in Maryland, Virginia, Kentucky, Tennessee, and Ohio. (See Pl. Dis. Bul. 4: 52, 79, 98.) In Massachusetts and Wisconsin it was local and caused little damage. In both Connecticut and Virginia it was more important than in the preceding year and caused losses estimated at 5-10% and at 4%, respectively. It was found to be present to some extent in 20% of the fields inspected in Virginia. In Kentucky wildfire and angular-spot together caused a loss estimated at 25%. In Georgia wildfire was less destructive than during 1919, according to E. C. Westbrook, Field Agent in charge of tobacco work of the Georgia State College of Agriculture, who reported as follows (in letter to F. D. Fromme, Nov. 23, 1920):

> "In 1919 Georgia lost very heavily from wildfire. It was not unusual to see a 25 acre field almost totally destroyed. That year we had a very rainy season. Last year (1920) we did not have as much wildfire, but there was quite a little damage in some sections."

In Virginia, wildfire appeared at about the same time and was most injurious during the same period as the angular-spot. In Connecticut it was first noticed July 10 at Windsor and did most damage in July. In Kentucky the first observation was made May 21 in seed beds at Wilmore.

As with the angular-spot, the severity of wildfire is dependent upon weather conditions. Heavy rainfall is said to be essential both for the spread and the development of the disease. The unusual season of 1920 seemed to be particularly conducive to outbreaks of these leaf spots.

Control measures recommended are the same as for angular-spot.

In Kentucky the variety Yellow Prior was said to be resistant to the leaf spot diseases.

Black root rot caused by Thielavia basicola (B. & Br.) Zopf.

Root rot was apparently favored by weather conditions and was more severe than usual in most states where it occurred. It was reported from Massachusetts, Connecticut, Maryland, Virginia (Charlotte County only), Kentucky, Georgia, Ohio, and Wisconsin, and also from the Philippine Islands. In Massachusetts, tobacco fields were generally severely affected in the early part of the season, but outgrew the disease later. In Kentucky, root rot was said to be most serious in the sections where Burley tobacco was grown. In the Philippines it is the worst disease of tobacco, according to H. Atherton Lee.

The use of resistant strains is probably the best method of controlling the disease (See Phytopath. 11: 49, January 1921), and was reported as giving good results in Kentucky, where complete control was obtained, Ohio, and Wisconsin. In Ohio, steaming of the plant beds was also recommended.

Other diseases.

Mosaic (cause not definitely determined) was reported by collaborators from Massachusetts, Connecticut, Virginia, Kentucky, and Wisconsin, and by James Johnson from Maryland and Pennsylvania. Except in Massachusetts, where it was only locally severe, Pennsylvania, and Virginia, where it is said to be rarely serious, the disease was apparently more important than usual. (See Pl. Dis. Bul. 4: 80 and 99, 1920). In Wisconsin it is ordinarily not severe, but caused considerable damage in 1920.

According to H. Atherton Lee, the disease also occurs in the Philippine Islands, affecting practically every plant that reaches maturity. Although it caused no complaints of loss, it probably injures the quality of the tobacco.

Leaf spot caused by Cercospora sp. was reported from the Philippine Islands by H. Atherton Lee.

Leaf spot caused by Macrosporium sp. was reported from Missouri.

Rust (non-parasitic) was reported from Pennsylvania, Kentucky, Tennessee, Ohio, Indiana, and Wisconsin. It caused considerable damage in some sections of Kentucky. According to True Houser in Ohio the disease attacked mosaic plants more readily than others. Connecticut Broadleaf, among other varieties, was said to be more susceptible to rust in Wisconsin.

Various leaf spot diseases, of unknown cause, were reported from several states.

White spot, Hartford and Middlesex Counties, Connecticut, appearing first on July 24.
Large brown spots, Goochland County, Virginia, September.
Black rust, Graves County, Kentucky, August 17.

Yellow french, cause undetermined, was reported from Ohio in the vicinity of Germantown and the Miami Valley by True Houser.

Frenching, cause unknown, occurred in Virginia and Wisconsin. In the former state it was said to be most severe on poorly drained land. Probably the same thing was reported from Connecticut under the name of "string leaf".

Hollow stalk caused by Bacillus carotovorus Jones - was reported from Massachusetts as more prevalent than usual, particularly on Broadleaf type, probably due to continued wet weather after topping.

Stem canker caused by Sclerotinia sp. was reported from Middlesex County Connecticut, where it first appeared August 17 at Cromwell.

Bacterial wilt caused by Bacterium solanacearum EFS. was reported from

Fluvanna County, Virginia, where it was severe in several cases, and was first observed on September 3. It was also reported by H. Atherton Lee from the Philippine Islands.

Wilt caused by Sclerotium rolfsii Sacc. was reported from the Philippine Islands, where it is said to be more serious in the foothills than on the lowlands, due likely to the longer dry season of the latter situation.

Root rot associated with Alternaria sp. was found once or twice in seed beds in Hartford County, Connecticut. It has not been definitely proven that the Alternaria is parasitic.

Damping-off and root rot caused by Rhizoctonia solani Kühn was general in Connecticut, occurring in both seed bed and field. Damping-off caused by Rhizoctonia sp. was also reported from Wisconsin, where soil sterilization was quite generally used as a control method, with good results.

Damping-off caused by Pythium debaryanum Hesse was reported from Connecticut and Wisconsin.

A seedling disease, caused by a fungus closely resembling Fusarium affine Faut. & Lamb, was described during 1920 by C. M. Slagg from Fayette County, Kentucky, where it was observed in June 1918 (Phytopath. 11: 49. 1921. Abst.) It causes spotting on the leaves and browning and girdling and, in humid air, damping-off of the stems.

Rosette, cause unknown, was reported as more abundant than usual in the Germantown and Miami Valley sections of Ohio by True Houser. Root rot, mosaic, and nematodes are said to be commonly found affecting plants with the rosette disease.

Fertilizer burn, caused chiefly by silicate of soda used too strong, was reported from Connecticut.

Lightning injury was reported from Windsor, Connecticut. A so-called "crookneck disease" which made its first appearance shortly after severe electrical storms and was thought to be due to lightning injury, was reported from Kentucky. Injured areas 40 feet in diameter were found in one field the day following a storm during which lightning struck several times.

DISEASES OF MISCELLANEOUS VEGETABLE CROPS.

ARTICHOKE (Globe)

Botrytis sp. was reported from California by G. K. K. Link as follows (News Notes of the Office of Cotton, Truck, and Forage Crop Disease Investigations, Feb. 28, 1920):

> "In the artichoke district near Half Moon Bay I found plenty of the Botrytis in the field killing green, succulent shoots and attacking the heads at the tips of the bracts. The fungus gets started in the wounds caused by cutting the heads."

The disease also occurred at Colma on the live plants as well as on trash. D. G. Milbrath estimated the reduction in yield from Botrytis at 2%.

Inspections at various markets showed the presence of gray mold rot in 11 cars of California artichokes, in amounts ranging from 2-100%, usually from 11-15%, averaging 33%.

ASPARAGUS

Rust caused by Puccinia asparagi DC. apparently did very little damage during 1920. It was reported from Vermont, New Jersey, Georgia, Texas, Ohio, Michigan, Minnesota, Iowa, Missouri, Washington, Oregon, and California. Dates when the disease was first noticed were June 27, Anoka County, Minnesota; September 20, Vermont.

Dwarfing, of undetermined cause, but with which Fusarium sp. was always associated, was again reported from New Jersey.

Winter injury was reported from Washington.

BEET (Garden)

Leaf blight caused by Cercospora beticola Sacc. was reported from New Jersey, West Virginia, Georgia, Texas, Ohio, Indiana, and Minnesota. It was of little importance, although common in some states.

Stem rot caused by Rhizoctonia sp. was reported from New York, Pennsylvania, and Washington. Only one report was received in each case. In Pennsylvania it occurred as a seedling disease, and in New York it caused large black cankers and rotting at the bases of the petioles.

Scab caused by Actinomyces scabies (Thax.) Güssow was reported from Connecticut and Ohio.

Root knot caused by Heterodera radicicola (Greef) Müll. was reported from Texas and Indiana. In the latter state it has occurred for the past six years in one area of muck soil near Goshen.

CARROT

Watery soft rot caused by Sclerotinia libertiana Fckl.

Sclerotinia rot was reported only from New York, where it was observed on May 13 at Orient, Long Island.

The following table shows the amount of watery soft rot found by inspectors of the Bureau of Markets in shipments of carrots:

Table 100. Prevalence of watery soft rot of carrot as determined by food-products inspectors of the Bureau of Markets, 1920.

Origin of shipment	No. of cars inspected	No. of cars with decay	Av. % of decay	Date of inspection	Market where inspected	Percent of decay	Remarks
Calif.	7	3 1/3	14	Mar. 31	St. Louis	12-15	
				June 30	Chicago	3-5	
				July 1	St. Paul	20-30	
				Aug. 9	New Orleans	10-15	1/3 of car.

Origin of shipment	No. of cars inspected	No. of cars with decay	Av. % of decay	Date of inspection	Market where inspected	Percent of decay	Remarks
Ill.	3	4	52	Dec. 17	Boston	4	
				Dec. 20	Chicago	25-30	Large pits at stem.
				"	"	75-100	Advanced stage.
				"	"	90	" "
La.	2	2	55	Mar. 16	Chicago	80-90	
				June 17	Detroit	25	With Rhizopus rot. Worst in upper tiers.
Miss.	1	1	45	June 18	Minneapolis	40-50	Decay in tops.
N. Y.	20	4	10	May 6	Washington	5	
				Nov. 1	New York	15-20	
				Nov. 9	"	15	
				Nov. 13	Pittsburgh	3-5	
Ohio	2	1	22	Dec. 9	Pittsburgh	20-25	
Ore.	2	2	20	Jan. 12	New Orleans	25-30	
				Feb. 9	Minneapolis	10-15	
Texas	3	2	20	May 4	St. Louis	2	
				May 28	Chicago	25-50	In tops.
Unknown	11	4	24	Feb. 16	New York	15	
				Mar. 17	Pittsburgh	15	
				Oct. 29	"	15-20	With slimy soft rot.
				Nov. 30	Washington	35-60	With gray mold rot and Rhizopus rot.

Total number of cars of carrots inspected 51
Total number of cars with watery soft rot 24

Other diseases.

Rot due to Bacillus carotovorus Jones caused complete loss of the crop of several fields in Philadelphia County, Pennsylvania.

Root knot caused by Heterodera radicicola (Greef) Müll. was reported from Ohio and from Indiana. In the latter state it occurred only near Goshen.

CELERY

Late blight caused by Septoria petroselini apii Br. & Cav.

Late blight was reported by collaborators from Massachusetts, Connecticut,

New York, New Jersey, Pennsylvania, Ohio, Indiana, and California. In most of these states the disease was generally prevalent, occurring wherever celery was grown.

Most states reported late blight as being present in about the same amounts as usual, or less. In Massachusetts and Pennsylvania, however, it was said to be more important than usual, especially so in the former state, where it caused a reduction in yield estimated at 15%. No estimate was made of the average loss in Pennsylvania, but in individual fields it ranged as high as 50-75% of the crop, and in New York, where the average loss was reported at 2-4%, fields with 100% infection were observed. In California according to D. G. Milbrath the disease was more severe than during 1919, causing a 10% reduction in yield in most of the trucking districts except the Delta region, where no late blight occurred.

Late blight was found by inspectors of the Bureau of Markets in celery shipped from New York, Florida, Michigan, and California, as shown in the following table:

Table 101. Prevalence of late blight of celery in shipments examined by inspectors of the Bureau of Markets, 1920.

Origin of shipment	Market where inspected	No. of cars with decay	Date inspected	Percent affected plants	Remarks as to severity of late blight
Calif.	Omaha	2	Jan. 17-23	1 car 33; 1 " 100	On top leaves.
	Kansas City	1	Feb. 25	50-100	In 2-4 leaves.
	St. Louis	1	Mar. 20	100	Outer leaves badly affected.
	Chicago	1	Mar. 30	100	" " " "
	Ft. Worth	1	Dec. 13	--	Most of stock showed late blight on leaves and stalks.
Fla.	Cleveland	1	Apr. 10	100	On practically all stalks.
Mich.	Columbus	1	Nov. 18	35	Badly spotted leaves.
N. Y.	Pittsburgh	1	Oct. 20	35-50	Leaves badly spotted.
	"	1	Dec. 15	--	Tops conspicuously spotted.
Unknown	Pittsburgh	1	Oct. 19	75	Leaves badly spotted.

Total number of cars of celery with late blight 11
Approximate number of cars of celery inspected..... 368

Dates when the disease was first noticed were reported as follows:

June 28 ..... Albany, New York.
July 1 ..... Amherst, Massachusetts.
September 7 ..... Philadelphia County, Pennsylvania.

The exceptionally cool and wet season was probably partly responsible for the heavy loss in Massachusetts. Late blight was said to be most severe during

October in that state.

Varieties reported by collaborators as susceptible to the disease are Golden Self Blanching in Massachusetts, and Easy Self Bleaching, White Plume, Golden Self Blanching, and Winter Green in Pennsylvania. The green varieties were more resistant in Massachusetts.

Six applications of 5-5-50 Bordeaux were said to give satisfactory control of the disease in New York.

Early blight caused by Cercospora apii Fr.

Early blight was reported from Vermont, Massachusetts, Connecticut, New York, New Jersey, Pennsylvania, Ohio, Indiana, and California. Apparently it caused very little damage in most cases, but in Indiana it was said to be of considerable importance, especially late in the fall, and Connecticut reported more than the usual amount. In New York it was found only in Albany County, where it caused no loss.

Inspectors of the Bureau of Markets reported the presence of the disease in shipments from Florida only. The following table shows the amounts found in individual cars.

Table 102. Prevalence of early blight of celery in shipments from Florida as reported by food-products inspectors of the Bureau of Markets, 1920.

No. of cars	Date inspected	% affected plants per car	Remarks.
3	Feb.27-Mar.4	10-15	-
		--	25% of crates showed decay ranging from a few spots in outer leaves to entire stalk.
		15-20	-
2	Mar. 10-13	--	All visible crates at doors showed early blight.
		66-75	Leaves or 2-5 outer branches slightly affected.
3	Apr. 8-10	--	Most outer leaves in top layer, an occasional leaf in second layer.
		--	Leaves in top layer show early blight.
		75	-
2	Apr. 13-21	About 100	Found in practically all crates.
		100	In tops of practically all stalks.
5	May 8-14	50-65	-
		50-65	-
		50-65	-
		--	Most tops in third layer affected.
		100	All stock with leaves and branches affected.
4	May 14-21	100	-
		100	-
		100	-
		100	-

Dates when the disease was first observed were reported as follows:

August 23 ..... Westville, Connecticut.
September 1 ..... Vermont.
September 15 ..... Lancaster County, Pennsylvania.

Foot rot and watery soft rot caused by Sclerotinia libertinia Fckl.

Sclerotinia was reported from New York and New Jersey as unimportant in the field. In New York it occurred to some extent in all celery sections, but the loss caused was not more than a trace. In California and Florida foot rot was an important field disease in the early part of the year, according to G. K. K. Link and I. C. Jagger, respectively. Fields with 25% infection were noted in the vicinities of El Monte and Watsonville in the former state. The reduction in yield for the state is estimated at 3% by D. G. Milbrath. The disease is favored by the dirt bank method of blanching which is used and by the heavy fogs and cool weather prevailing in these section, as in most of the trucking districts of California.

Inspectors of the Bureau of Markets reported watery soft rot as occurring in shipments of celery from California, Canada, Florida, Michigan, New York, and Ohio. The amounts of infection are shown in the table below, in which the percentage figures refer to percentages of affected plants, not to severity of decay. In most cases the leaves and from 1-3 to 5-9 of the outer branches were involved. In a considerable number of cars, however, the decay was largely complete, especially in the upper tiers, as indicated in the following reports:

California: "Fifty to seventy-five per cent decay, one-third of which was complete and the balance in the outer branches." "Practically all crates in the top layer and in the bottom layers between the doors showed complete decay."

Table 103. Amounts of watery soft rot of celery found in carload shipments examined by food-products inspectors of the Bureau of Markets, 1920.

Origin of shipment	Total No. of cars shipped	Number of cars inspected	No. of cars with decay	Percentage of affected plants: Number of cars with					No. cars with percentage given	Av. % affected plants
				t-10%	10-25%	25-50%	50-75%	75-100%		
Calif.	2273	95	49	7	6	5	6	13	37	53
Canada	--	2	1	-	-	-	-	1	1	75
Fla.	3010	167	114	10	23	36	18	5	92	38
Mich.	549	23	2	1	-	-	-	-	1	2
N. Y.	2628	77	35	1	6	7	4	14	32	59
Ohio	--	2	2	-	-	-	-	2	2	87
Unknown	--	12	3	1	-	-	1	-	2	32

Total number of cars shipped 9024
Approximate number of cars inspected 368
Total number of cars with decay 207

Florida: "Fifty to seventy-five percent decay in top layers and 15-40% in the bottom layers, one-third of the decay being complete." "All stalks in top layer showed decay, being practically worthless; one-fourth to two-thirds of the stalks in the lower layers were decayed."

New York: "Practically all stalks completely decayed."

Yellows caused by Fusarium sp.

Yellows, or the stunting disease, as it has been previously known, was reported from Indiana as less important than in previous years, due to the use of the variety Easy Bleaching instead of the extremely susceptible Golden Self Blanching. G. H. Coons and R. Nelson report as follows concerning this disease (Phytopath. 11: 1921):

"The stunting disease of celery first discovered at Kalamazoo in 1914, as a serious disease of the Golden Self Blanching variety, has increased in extent so that practically all soil in the immediate vicinity of that city is no longer able to raise this particular variety. The disease is also known from all other extensive celery districts in the state. It is also a serious disease in New Jersey, Indiana, Massachusetts, and Connecticut. Although first suspected as being of bacterial origin, and reported by other observers as due to the joint action of bacteria and Fusarium, definite proof is now available for assigning to a new species of Fusarium the causal relationship of this disease for which the name Celery Yellows is proposed. The variety Easy Bleaching and all of the so-called green varieties are tolerant to this disease. In the golden varieties excessive stunting occurs, accompanied by yellowing and thickening of the foliage, together with reddening of the vascular system.

Other diseases.

Bacterial crown and heart rot, due to organisms of the Bacillus carotovorus and B. apivorus type, was reported from New Jersey, where it was said to have caused heavy losses for a number of years, particularly where the Golden Self Blanching variety was grown on muck soils. If planted before May 15, however, this variety usually produces a good crop. The green varieties are only slightly susceptible. Sterilization of the seed bed soil each year greatly reduces the loss from this disease. (Poole, R. F. Recent studies on bacteriosis of celery (Abstract) Phytopath. 11: 1921).

Black heart, cause undetermined, was reported from the vicinity of Sanford, Florida in the early part of April by I. C. Jagger, as follows:

"Black heart of celery has become quite destructive during the past few days, apparently having resulted from the setting in of more or less continuous warm weather. Probably 90% of the Golden Self Blanching celery has been harvested, but apparently a considerable percentage of the remaining fields are going to show losses from black heart."

The disease was also reported from the Delta region and Los Angeles

County in California by D. G. Milbrath, who states that it was more important than during 1919, and caused a loss of 2%.

Bacterial leaf spot was reported from New York (as bacterial blight) and from Indiana. In New York the disease was found in all celery sections and although less severe than during 1919 and previous years, caused a loss of 3-5%. About a third of the fields were infested, in amounts from a trace to 100%. Because of dry weather in the early summer, the disease appeared late, August 1, and caused greatest damage later in the season. Bordeaux 5-5-50 in six applications gave satisfactory control in New York.

Gray mold rot, caused by Botrytis sp., was reported by G. K. K. Link in March as prevalent in most of the trucking sections of California, being favored by the heavy fogs and cool weather of the winter and spring months.

Rhizoctonia was said to be more prevalent than usual in Ohio, due to the abundant moisture.

A root rot of unknown cause was reported from Massachusetts as less prevalent than usual. The susceptible variety Golden Self Blanching is now little grown in that state.

Root knot due to nematodes was found in one area near Goshen, Indiana.

A wilted condition of outer leaves was reported from the vicinity of Sacramento, California by G. K. K. Link, as follows (News Notes of the Office of Cotton, Truck, and Forage Crop Investigations, Feb. 28, 1920):

> "The most serious thing in celery this year has been a wilted, dried-out, pithy condition of the outer leaves, that is, petioles, and a brown yellowish condition of the leaf blades. This condition has been laid at the door of the carriers by some and attributed to field freezing by others. There is no doubt that it originated in the field."

EGGPLANT

Fruit rot caused by Phomopsis vexans (Sacc. and Syd.) Harter.

In 1920 fruit rot was reported by collaborators from New Jersey, Louisiana, and Iowa, and by inspectors of the Bureau of Markets in shipments from Florida (6 cars, average amount of fruit rot 15%). In Louisiana the disease was, as usual, very severe throughout the state, affecting nearly all fields and causing a reduction in yield estimated at 50-75%. It was first noticed in June at Baton Rouge, and caused most injury during the period from June to September.

In former years this disease has been reported to the Survey from all of the states east of the Mississippi River except northern New England, Maryland, North Carolina, and Kentucky, and from Iowa, Missouri, Nebraska, Louisiana, Texas, Oklahoma, California, and Porto Rico. It does considerable damage annually in New Jersey, Florida, Alabama, and Louisiana.

In most cases the cause has been reported as Phyllosticta hortorum Speg. According to Harter (Journ. Agr. Res, 2: 331-338. 1914) true Phyllosticta hortorum does not occur in this country, and the disease which has been generally reported as due to that fungus is caused by Phomopsis vexans.

Bordeaux mixture has not given satisfactory results in controlling the disease in Louisiana, Virginia, and Porto Rico. In Florida, seed bed sterilization, clean seed, and crop rotation are recommended.

Other diseases.

Bacterial wilt caused by Bacterium solanacearum EFS. - reported from Ohio (first noticed September 22).

Verticillium wilt caused by Verticillium sp. was reported from Massachusetts as very important (first observation 1919), and from New Jersey as generally destructive.

Root rot caused by Fusarium sp. was reported from New York as follows:

"Reported only from Albany County where it evidently injured 10-15% of the crop. Did great damage in cold frames. Becoming serious in many fields - spreading fairly rapidly. First observed May 24."

Alternaria sp. - reported from Pennsylvania.

Anthracnose caused by Gloeosporium melongenae Ell. & Hal. - reported from West Virginia by J. L. Sheldon as follows:

"Several times during the summer I saw badly diseased fruits in the Morgantown, Monongalia County, markets. Some of these were raised near town while the early ones were shipped in."

LETTUCE

Drop and watery soft rot caused by Sclerotinia libertiana Fckl.

Drop was reported by collaborators from Massachusetts, New York, New Jersey, Texas, Ohio, and Minnesota, and from Florida and California by I. C. Jagger and G. K. K. Link, respectively. In New York and Texas it was said to

Table 104. Amounts of watery soft rot of lettuce, caused by Sclerotinia libertiana, in shipments examined by food-products inspectors of the Bureau of Markets, 1920.

Origin of shipment	Number of cars inspected	No. of cars with decay	Percentage of affected plants in individual cars — Number of cars with: 1-10%	10-25%	25-50%	50-75%	75-100%	No. of cars with % given	Average percent affected plants
Ariz.	11	6	-	-	-	2	2	4	79
Calif.	408	63	7	2	2	3	27	41	75
Fla.	59	16	2	3	8	2	1	16	32
Minn.	1	1	-	-	-	1	-	1	50
N. Y.	59	8	2	-	5	-	1	8	36
S. C.	6	2	1	-	-	-	1	2	55
Texas	21	8	-	-	3	2	3	8	59
Wash.	14	4	-	2	1	-	1	4	44

Total number of cars inspected 613
Total number of cars with decay 108

be unimportant. In Massachusetts, however, it caused an estimated loss of 15% in greenhouse lettuce, and in Minnesota the loss in the field was placed at 10%.

Inspectors of the Bureau of Markets found watery soft rot in lettuce shipped from New York, South Carolina, Florida, Texas, Minnesota, Arizona, Washington, and California. Table 104 gives the percentages of affected plants reported.

Soil sterilization was useful as a control measure in Massachusetts. In Minnesota it was reported that no treatment was used, and that continued cropping of lettuce on peat bogs was increasing the severity of the disease.

Gray mold rot caused by Botrytis cinerea Pers.

Gray mold rot was reported from Massachusetts, New York, Ohio, Indiana, and Iowa, and by G. K. K. Link from California. In Massachusetts, Indiana, and Iowa it was, as usual, an important greenhouse disease, causing a loss of 1% of the crop in Iowa. In New York it caused slight damage, although found occasionally in all lettuce sections. The disease was severe in the field in many parts of California in the early part of the year.

Bureau of Markets Inspectors reported Botrytis rot in lettuce from New York (8 cars) and California (7 cars) only.

Downy mildew caused by Bremia lactucae Regel.

Downy mildew occurred as a greenhouse disease in Massachusetts, Ohio, Indiana, Michigan, and Iowa. In Indiana and Iowa it was reported as causing serious losses. I. E. Melhus reported as follows concerning the disease in the latter state (Same as abstract in Phytopath. 11: 1921):

> "Under Iowa conditions Bremia lactucae has caused serious losses to the greenhouse lettuce crop. It is most rampant on plants in the seedling stage. This organism, like some species of Cystopus and Phythphthora, flourishes only at low temperatures and in an atmosphere of very high humidity. The optimum temperature for its spore germination is from 6 to 10°C., a temperature which prevails in the lettuce houses during the winter and spring months. The wild species of Lactuca: L. scariola var. integrata, L. canadensis, L. sagittifolia, and L. ludoviciana, are common as foul weeds about compost piles, vacant lots, and fence corners. All of the above species are readily infected with Bremia lactucae occurring on cultivated lettuce and vice versa. The downy mildew probably spreads from the wild to the cultivated lettuce. In this latitude the wild species of Lactuca are winter annuals and may serve as means for carrying the organism over from one season to the next in the vegetative stage. Although very frequent search has been made for oospores in cultivated lettuce plants, none have been found. Bremia is able to survive in hot-house soil from year to year, providing it is not allowed to freeze. The control of this disease has been effected by spraying the lettuce seedlings with Bordeaux mixture (4-4-50) two or three times before they are transplanted."

The disease was reported on field-grown lettuce in New York and Texas, where it was unimportant, and in California, where it caused a loss of 2%, according to D. G. Milbrath.

Downy mildew was found by Bureau of Markets inspectors in lettuce shipped

from New York (5 cars, average percentage affected plants 69%) and California (42 cars, average percentage affected plants 81%).

Stem rot and rosette caused by Rhizoctonia sp.

Rhizoctonia was reported as an important disease only from New York, where it was generally destructive and caused a 15-20% reduction in yield. Many fields were a total loss and were plowed up without harvesting. The Romaine type of lettuce was less frequently attacked than the Boston head, which touches the ground.

The disease was also reported from Pennsylvania and Ohio.

Dates of first appearance were reported as follows:

February 17 ..... Ohio.
June 26 ..... Williamson, New York.
July ..... Pennsylvania.

Tip-burn (non-parasitic).

Tip-burn apparently was not so generally serious as in the previous year. It was reported from New York, Texas, and Idaho, and California. In New York it was said to be, as usual, very severe, particularly in the middle of the summer, causing a loss of about 10%. It was first noticed June 26 at Williamson. In California the disease appears on butter head varieties only, according to D. G. Milbrath, who estimated a loss of 20% in the southern part of the state. It was first noticed in January.

The disease was unimportant in Texas and Idaho, although one grower in the Boise Valley in the latter state lost 13 acres, which he had planted too late in the spring.

On lettuce in transit the disease was also less prevalent than in 1919, at least, it was reported by markets inspectors in shipments from New York, Florida, and California only, as shown in the following table:

Table 105. Losses caused by tip-burn of lettuce as shown by examination of cars at destination by food-products inspectors of the Bureau of Markets, 1920.

Origin of shipment	Number of cars inspected	Number of cars with tip-burn	Average percentage of tip-burn	Range of percentage of tip-burn	
				No. of cars	Percent
California	408	3	15	3	5-25
Florida	59	2	—	1	20
New York	59	7	63	2	100
				4	45-65
				1	t

Approximate number of cars inspected 613
Total number of cars with tip-burn 12

Leaf spots caused by Septoria lactucae Pass. and S. consimilis E. & M.

Both Septoria lactucae and S. consimilis have been reported to the Survey several times during previous years, as shown in the following table. In every case they were local in occurrence and caused no particular damage.

Table 106. Occurrence of Septoria lactucae and S. consimilis in the United States, as reported to the Plant Disease Survey.

Year	State reporting	Species
1903	Alabama	S. lactucae and S. consimilis (on Lactuca canadensis).
1906	New York	S. consimilis
	Virginia	S. lactucae
	North Carolina	"
1909	Ohio	S. consimilis
1913	Pennsylvania	S. consimilis
1915	New Jersey	S. lactucae
	Virginia	"
1916	Pennsylvania	S. consimilis
1918	New York	S. lactucae
	Pennsylvania	" (?)
	Arkansas	"
1920	Pennsylvania	S. lactucae

Other diseases.

Bacterial soft rots were reported from Florida, Texas, Ohio, Minnesota, and Washington. In Ohio the disease occurred generally in greenhouses, and was said to be especially bad on head varieties at maturity. Sug-irrigation gave good results in controlling it. In Minnesota it was of considerable importance in greenhouses.

The South Carolina bacterial disease, caused by Bacterium vitians Brown, was observed in a greenhouse at State College, Pennsylvania, December 13.

Black heart, cause undetermined, was reported by G. K. K. Link in March as an important disease in the Coachella and Imperial Valleys in California. According to D. G. Milbrath (January 2, 1921, in News Notes of the Office of Cotton, Truck, and Forage Crop Disease Investigations, January 22) this disease is one factor which will ruin the lettuce industry in the Imperial Valley if not controlled. Black heart was found also in shipments of lettuce from Washington examined at Chicago.

A bacterial root rot, apparently a new disease, was reported from Ohio as present in greenhouses. It was first observed November 8. Soil sterilization was suggested as a control measure.

Root rot caused by Ozonium omnivorum Shear, was reported from Graham County, Arizona, September 8.

A root rot of unknown cause, which caused a failure of the greenhouse crop in Kentucky and was also very severe in the field, was reported by W. D. Valleau as follows:

> "Both the butter-head and crisp head types of lettuce have been a failure under greenhouse conditions. The plants make a normal growth in the young stages, but later manifest various symptoms depending upon the variety. The butter-head types generally do not head, but produce large outer leaves with very small etiolated leaves in the center. The variety Hothouse often made small, very solid heads consisting of dark green leaves very much foreshortened, due to stunting of the mid-vein. Other varieties produced small rosettes of extremely wrinkled small, dark green leaves. The crisp head types developed normally until the time of filling out of the head when growth ceased, resulting in very loose leafy heads.
>
> "Tip-burn later appeared on most of the plants with the development of numerous laterals and an early elongation of the central axis. This was found to be particularly characteristic of the leaf variety Grand Rapids both in station greenhouse and in commercial houses at Louisville. Tip-burn was less marked on the leaf and crisp head than on the butter-head types.
>
> "A severe rotting of the roots was found in association with the various physiological conditions. The root-rot in commercial seed beds is very evident if young plants are dug and the roots carefully washed. It often results in the development of small wrinkled central leaves with small dead areas identical with the early stages of tip-burn.
>
> "Field observations indicate that the disease is widespread in Kentucky on both the leaf and head lettuce, resulting generally in a loss of more than 75% of the crop of the butter-head and a smaller per cent of the crisp types. Here also the root-rot is found to be associated with the losses.
>
> "Thus far steam sterilization and formaldehyde treatment of greenhouse soils have failed to control the trouble completely, but there are indications that more thorough methods may prove effective."

Root knot caused by Heterodera radicicola (Greef.) Müll. was reported from Massachusetts, Ohio, Indiana, and Arizona.

Internal necrosis was reported from King County, Washington.

MANGEL-WURZEL

Crown gall caused by Bacterium tumefaciens Smith and Towns. was reported from Bradford County, Pennsylvania, where it was first noted November 1.

Frost injury was reported from Pacific County, Washington.

OKRA

Wilt caused by Fusarium vasinfectum Atk. was reported from Georgia, where it occurred in the lighter soils in the southern part of the state, and

caused a 2% reduction in yield.

Verticillium wilt caused by Verticillium albo-atrum McA. was reported from Burlington County, New Jersey.

Root rot caused by Ozonium omnivorum Shear was prevalent in Texas, causing a loss estimated at 6%, and was also reported from Graham County, Arizona.

Root knot due to Heterodera radicicola (Greef) Müll. occurred in sandy soils in Texas, where it caused a reduction in yield estimated at .1%. In Arizona it caused severe damage in a garden in Thatcher, Graham County.

PARSLEY

Rot caused by Sclerotinia sp. was reported from a greenhouse in Albany County, New York, as completely destroying two beds of parsley.

Root canker caused by Rhizoctonia sp. was reported July 12 from Albany County, New York.

PARSNIP

Root knot caused by Heterodera radicicola (Greef.) Müll. was reported from Ohio (first collection; first observed October 2) and Indiana (negligible; in one area near Goshen).

PEA

Blight caused by Mycosphaerella pinodes Berk. and Blox.

Blight was reported from Massachusetts, New York, New Jersey, Pennsylvania, Delaware, Maryland, Ohio, Wisconsin, Montana, and California. In most cases it was general in distribution but caused little damage, although in Massachusetts it was said to be somewhat more important than usual, and in California it caused a reduction in yield of 6% in Alameda and San Diego Counties, according to D. G. Milbrath. In Montana it has been found only on low wet ground subject to flooding in spring and early summer.

Bacterial blight caused by Pseudomonas pisi Sackett.

Bacterial blight was reported from Pennsylvania as common but probably not important in Erie County, and from Montana. In the latter state it was said that certain short-stemmed varieties were apparently most susceptible.

Root rots caused by various organisms.

Root rots caused more loss to the pea crop than any other trouble, especially where adequate crop rotation was not practiced. In Wisconsin the loss from

root rot alone was estimated at 1%, and from root rot, bad weather, and lice at probably 25%. In Montana it was more than 5%. In Utah also root rots caused serious losses in some sections. In Delaware the disease was not nearly so serious as during 1919. The pea crop in that state was said to be the largest in years in spite of the serious outbreak of root rots in 1919.

Fusarium spp. are the most generally reported causes of root rot, but Pythium sp, and Rhizoctonia sp. are also important, usually in combination with each other or Fusarium, or both. Phytophthora cactorum has been reported from Connecticut, and Thielavia basicola from several states.

Fusarium root rot was reported from New York, New Jersey, Maryland, Virginia, West Virginia, Michigan, Wisconsin, Utah, and Oregon. In most cases it was said to be serious only in soils which had grown peas for a number of years in succession, and especially in home gardens. In Mason County, Michigan the variety Alaska was commonly affected by a serious root rot thought to be due to a Fusarium, and in Oregon a disease apparently caused by Fusarium sp. was observed for the first time in the vicinity of Salem. In New York the disease was first noticed April 7 in Suffolk County.

Pythium sp. was reported from Delaware, Maryland, Michigan, Wisconsin, Montana, and Utah. In Wisconsin it seemed to be the most important of the organisms causing root rot, and was generally distributed in old pea soils. Dates when the disease was first observed were reported as follows: May 13, Delaware; July 1, Madison, Wisconsin.

Rhizoctonia sp. was the most important cause of root rot in Montana, according to F. R. Jones. It was also reported from Wisconsin, Utah, and Washington.

Phythphthora cactorum (Lebert & Cohn) Schr. was reported from Connecticut in the vicinity of Westville, where it first appeared June 21. The disease probably occurred in 1919, but was reported as "Pythium sp. (?)".

Thielavia basicola (B. & Br.) Zopf. was reported as local in Connecticut, New York, and Pennsylvania. In Pennsylvania it was said to be confused with Fusarium and Rhizoctonia probably.

Septoria blight caused by Septoria pisi West.

Septoria blight was not particularly important although it was prevalent in most of the states where it occurred. It was reported from New York, Pennsylvania, Delaware, Maryland, Michigan, Wisconsin, and Montana. In Wisconsin it caused considerable damage in a few fields in old pea-growing sections in Sauk County. The disease was first observed at Madison, Wisconsin on June 25 and in Tompkins County, New York on August 20.

Powdery mildew caused by Erysiphe polygoni DC.

Powdery mildew was reported from Vermont, New York, Pennsylvania, Ohio, Minnesota, Idaho, and Washington. It caused little injury. Dates when it was first observed were reported as follows:

August 15 ..... Minnesota.
August 20 ..... Tompkins County, New York.
September 30 ..... Vermont.

Erysiphe sp. was reported from California by D. G. Milbrath, who states that he does not think it was Erysiphe polygoni. It destroyed both the leaves

and the vines, and caused a loss of 3% in San Diego, Riverside, and Los Angeles Counties. Sulphur dust was used as a means of control.

Other diseases.

Sclerotinia libertiana Fckl. was reported from State College, Pennsylvania, where it attacked a few plants trailing on the ground.

PEANUT

Leaf spot caused by Cercospora personata (B. & C.) E. was reported from western Tennessee, Georgia, Alabama, Mississippi, Louisiana, and Arkansas. It apparently was local and of little importance except in Louisiana, where it caused a reduction in yield estimated at 1%, and Arkansas, where it was said to be more severe than usual. The variety White Spanish was said to be more commonly affected than others in Tennessee, due perhaps to the fact that it was more mature at the time of the report (October 15).

A leaf blight with which Botrytis sp. was associated was reported from Tennessee as "fairly common in a field observed at Jackson in September by Sherbakoff".

Root rot caused by Sclerotium rolfsii Sacc. was reported from western Tennessee, and from Louisiana, where it was rather common but caused little injury.

Texas root rot caused by Ozonium omnivorum Shear was reported from Texas as unimportant on peanuts, which are usually grown in sandy soils where the disease does not occur.

PEPPER

Anthracnose caused by Colletotrichum nigrum E. & H. was reported from New Jersey and Georgia.

Mosaic, cause undetermined, was reported from New Jersey as apparently of very little importance, and from Lawrence County, Pennsylvania.

Fruit rot caused by Macrosporium sp. was reported from New Jersey.

Bacterial wilt caused by Bacterium solanacearum EFS. was reported from Texas as unimportant.

Wilt caused by Sclerotium rolfsii Sacc. was reported from Georgia, where it was said to be less important than usual, although it caused a reduction in yield estimated at 10%. It attacked all varieties.

Wilt, caused by Fusarium sp. caused a reduction in yield of chili and pimento peppers of 5% in Orange County, California, according to D . G. Milbrath.

Damping-off, cause unknown was reported from Rensselaer County, New York, where it first appeared May 24 at Troy.

Nematodes were reported from Luzerne County, Pennsylvania.

RHUBARB

Leaf spot caused by Phyllosticta straminella Bres. was reported from Albany County, New York, July 7. A Phyllosticta leaf spot was reported from Pennsylvania also.

Leaf spot caused by Ascochyta rhei E. & E. was reported from Indiana as probably generally distributed.

Crown rot caused by a new species of Phytophthora was reported by W. S. Beach (Phytopath. 11: 55-56. Jan. 1921) as prevalent in Philadelphia County, Pennsylvania. The disease is most severe in wet weather. A similar crown rot, due to another species of Phytophthora is reported by G. H. Godfrey as occurring to a serious extent in Maryland, District of Columbia, and Virginia.

Root rot caused by Bacillus carotovorus Jones was reported from Ohio.

Root rot caused by an undetermined fungus was reported from Stoddard County, Missouri.

SALSIFY

White rust caused by Albugo tragopogonis (DC.) Gray was reported from Vermont and Iowa, causing little injury in both cases.

SPINACH

Blight (cause undetermined).

Blight (mosaic) was reported from Beaver County, Pennsylvania (first report for state) where it was rather serious, from Texas as unimportant, from the vicinity of Goshen, Indiana, and from California by D. G. Milbrath. In California it was said to be prevalent in Los Angeles County where the Bloomsdale and Prickly varieties were grown. The crop was unfit for shipment and was used for canning. The loss for the county was estimated at 30%, and for the state at 1%.

Downy mildew caused by Peronospora effusa Rabenh.

Downy mildew was reported from Texas as very important wherever spinach was grown, causing a reduction in yield estimated at 10%. It was said to be more prevalent than during the preceding year, due perhaps to the very wet weather. The disease also caused heavy losses in the Imperial Valley in California where it was becoming the limiting factor in spinach culture, according to D. G. Milbrath. The crop was largely plowed under. Twelve hundred acres that were expected to ship two hundred cars of spinach shipped only ten. The reduction in yield was estimated at 60%.

Other diseases.

Anthracnose caused by Colletotrichum spinaciae E. & H. was reported from

Texas as unimportant.

Scab or black mold, caused by Cladosporium macrocarpum Preuss. - reported from Beaver County, Pennsylvania (first report for state, not serious), and from Texas.

Root rot and wilt caused by Fusarium sp. - reported from Idaho, where it occurred in gardens at Moscow.

Rhizoctonia sp. - reported from Philadelphia County, Pennsylvania.

SWISS CHARD

Leaf spot caused by Cercospora beticola Sacc. was reported from Pennsylvania as unimportant though generally prevalent.

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